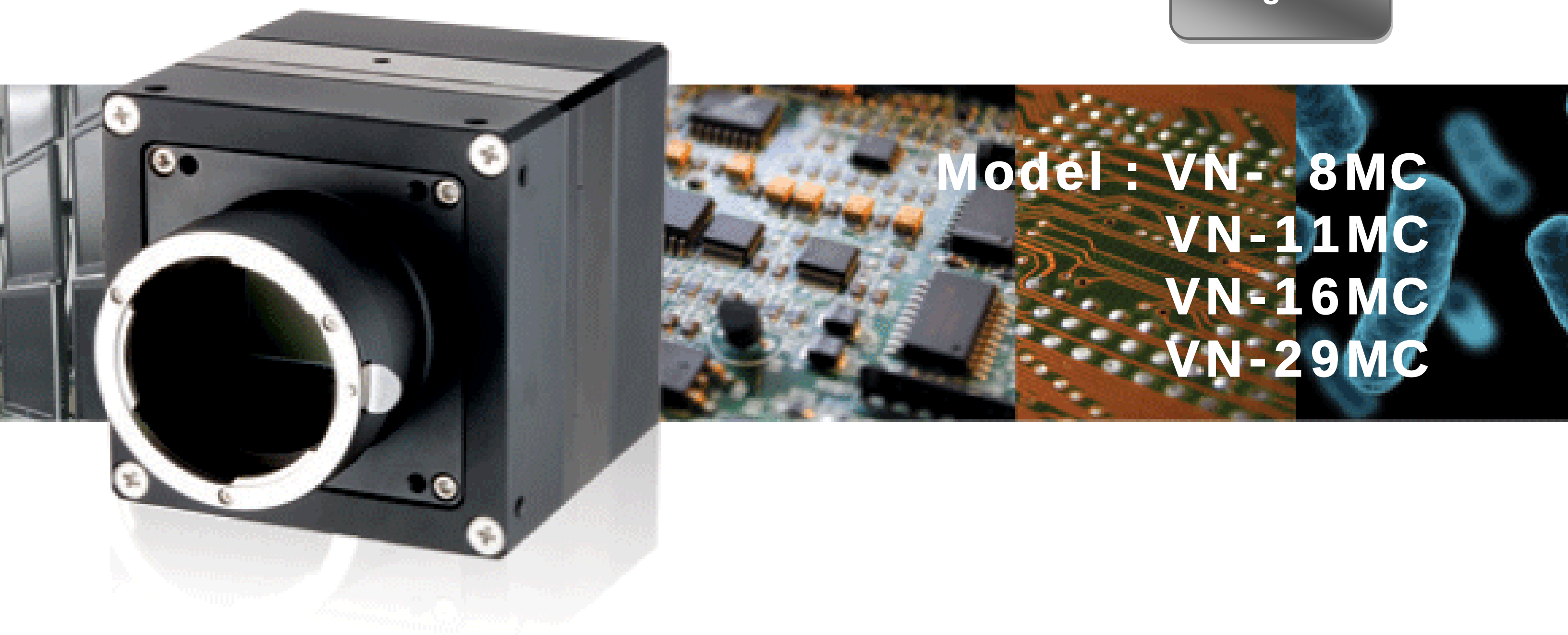
User Manual

English



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Revision History

Version	Date	Descriptions
1.0	2011/05/24	Initial release
1.1	2011/7/8	Added 4 Tap readout mode of VN-8MC and Sequence mode content, updated all related tables and figures. Fixed Minor errors.
1.2	2011/12/22	Added VN-29MC
1.3	2012/4/4	Added Stage Check Corrected errors
1.4	2013/06/14	• Added description of M5 set screws for tilt adjustment • Revised spectral response according to the updated TSI datasheets • Added Actual Time Applied for Commands • Removed the Horizontal Flip feature from VN-8MC and VN-29MC
1.5	2013/08/06	Corrected position setting values in the 16 Shot Bayer Color sequence mode
1.6	2013/08/21	Added DSNU Correction feature to VN-8MC and VN-29MC

Contents

1 Precautions

General

- Do not drop, damage, disassemble, repair or alter the device.
- Do not let children touch the device without supervision.
- Do not use the device for any other purpose then specified.
- Contact your nearest distributor in case of trouble or problem.

Installation and Maintenance

- Do not install the device in a place subject to direct sun light, humidity, dust or soot.
- Do not place magnets near the product.
- Do not place the device next to heating equipments.
- Be careful not to let liquid like water, drinks or chemicals leak inside the device.
- Clean the device often to remove dust on it.
- In clearing, do not splash water on the device but wipe it out with smooth cloth or towel.

Power Supply

- It is recommended the use of 12V DC with ±10% of voltage, over 1A of output current with KC, CE or other local certification. If voltage over 16V is supplied, it will cause damages to the device.

  ※ Vieworks Co., Ltd. does NOT provide power supplies with the devices.

2 Warranty

For information about the warranty, please contact your local dealer or factory representative.

3 Compliance & Certifications

3.1 FCC Declaration

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at own expenses.

3.2 CE : DoC

EMC Directive 2004/108/EC.
Testing Standard EN 55022:2006+A1:2007, EN 55024:1998+A1:2001+A2:2003
Class A

3.2.1 KCC Statement

Type	Description
Class A (Broadcasting Communication Device for Office Use)	This device obtained EMC registration for office use (Class A), and may be used in places other than home. Sellers and/or users need to take note of this.

4 Package Components

Package Components

VN Camera (F-Mount)

Mount Plate (Optional)

M5 Set Screws for Tilt Adjustment (Provided only with F-mount camera)

 CAUTION	• You can adjust the tilt using the M5 set screws, however it is not recommended since it is adjusted as factory default settings. • If the tilt settings need to be adjusted inevitably, please contact your local dealer or factory representative for technical support.

5 Product Specifications

5.1 Overview

The VN Camera Link series is a progressive scan, high-resolution industrial area scan cameras. All functions of VN cameras can be programmed and updated in the field. The image processing and controls of VN Camera Link series is based on embedded FPGA with a 32-bit microprocessor. Furthermore, the VN Camera Link series has improved resolution by using pixel shift technology. A XY Stage is precisely shifted as nanometers unit so that the image sensor can be moved in X and Y direction (1/2 or 1/3 pixel distance) while taking images.

Main Features

- Area Of Interest
- Trigger Mode
- Binning Mode – 2 × 2 / 4 × 4
- Output Width – 8 / 10 / 12 bit
- Output Channel – 1 Tap / 2 Tap / 4 Tap
- Auto Taps Adjustment
- Electronic Shutter
- 2D Flat Field Correction
- Strobe Output
- Analog Gain adjustment function
- Analog Offset adjustment function
- Look Up Table
- Defective Pixel correction
- Flat Field Correction
- Test Image
- Horizontal Flip (Only available on VN-11MC and VN-16MC)
- Image Invert
- RS-644 Serial Communication
- Temperature Monitor
- Field Upgrade
- Base Camera Link
- Nanometer Pixel Shift

*** 4 Tap output channel mode or 4 tap mentioned in this document is only supported on VN-8MC.**

5.2 Technical Specification

VN Series		VN-8M	VN-11M
Active Image (H × V)		3296 × 2472	4008 × 2672
Sensor Type		Kodak KAI-08050	Kodak KAI-11002
Pixel Size		5.5 ㎛ × 5.5 ㎛	9.0 ㎛ × 9.0 ㎛
Sensor Output		1, 2 or 4 Tap Output	1 or 2 Tap Output
Video Output		8/10/12 bits, 1 or 2 Tap	
Camera Interface		Camera Link (Base)	
Electronic Shutter		Global Shutter	
Max. Frame Rate at Resolution	×1 (1 Shot)	16.3 fps @ 8.1 M (3296 X 2472)	6.4 fps @ 10.7 M (4008 X 2672)
	×4 (4 Shot)	4.1 fps @ 32.6 M (6592 X 4944)	1.6 fps @ 42.8 M (8016 X 5344)
	×9 (9 Shot)	1.8 fps @ 73.3 M (9888 X 7416)	0.7 fps @ 96.4 M (12024 X 8016)
Pixel Clock		40/80 ㎒	30/40 ㎒
Exposure Time		1/100000 sec ~ 7 sec (10 ㎲ step)	1/7000 sec ~ 7 sec (10 ㎲ step)
Partial Scan (Max. Speed)		84 fps at 300 Lines	27 fps at 334 Lines
Gamma Correction		User defined LUT (Look Up Table)	
Black Offset		Adjustable (0~127 LSB at 12 bits, 256 step)	
Video Gain		Analog Gain : 0 ~ 32 ㏈, 900 step	
Trigger Mode		Mode(Free-Run , Overlap, Fast, Double), Programmable exposure time and trigger polarity	
External Trigger		External, 3.3 V - 5.0 V, 10 ㎃, optically isolated	
Software Trigger		Camera Link CC1, Programmable Exposure	
Dynamic Range		>62 ㏈	
Control		RS-232C via Camera Link (115.2 K bps)	

Table 5.1 Specifications of VN Series VN-8M and 11M (continuous)

VN Series	VN-8M	VN-11M
Shift Range	0 ~ 15 ㎛, 1 ㎚ step	
Shift Resolution	0.001 ㎛	
Shift Control	Manual Mode or Sequence Mode (4/9 Shot Mono, 4/16/36 Shot Color)	
Shift Latency	< 8 ㎳	
Lens Mount	F-mount	
Power	10~14 V DC, Max. 6 W	10~14 V DC, Max. 10 W
Environmental	Operating: 10℃ ~ 40℃, Storage: -30℃ ~ 65℃	
Mechanical (H × V × D)	90 ㎜ × 90 ㎜ × 123 ㎜, 1.2 kg	

Table 5.2 Specifications of VN Series VN-8M and 11M

VN Series		VN-16M	VN-29M
Active Image (H × V)		4872 × 3248	6576 × 4384
Sensor Type		Kodak KAI-16000	Kodak KAI-29050
Pixel Size		7.4 ㎛ × 7.4 ㎛	5.5 ㎛ × 5.5 ㎛
Sensor Output		1 or 2 Tap Output	1 or 2 Tap Output
Video Output		8/10/12 bits, 1 or 2 Tap	
Camera Interface		Camera Link (Base)	
Electronic Shutter		Global Shutter	
Max. Frame Rate at Resolution	×1 (1 Shot)	4.2 fps @ 15.8 M (4872 × 3248)	5 fps @ 28.8 M (6576 × 4384)
	×4 (4 Shot)	1.1 fps @ 63.3 M (9744 × 6496)	1.3 fps @ 115.3 M (13152 × 8768)
	×9 (9 Shot)	0.5 fps @ 142.4 M (14616 × 9744)	0.6 fps @ 259.5 M (19728 × 13152)
Pixel Clock		30/40 ㎒	40/80 ㎒
Exposure Time		1/4500 sec ~ 7 sec (10 ㎲ step)	1/100000 sec ~ 7 sec (10 ㎲ step)
Partial Scan (Max. Speed)		17 fps at 406 Lines	16 fps at 1000 Lines

Table 5.3 Specifications of VN Series VN-16M and 29M (continuous)

VN Series	VN-16M	VN-29M
Gamma Correction	User defined LUT (Look Up Table)	
Black Offset	Adjustable (0~127 LSB at 12 bits, 256 step)	
Video Gain	Analog Gain : 0 ~ 32 ㏈, 900 step	
Trigger Mode	Mode(Free-Run , Overlap, Fast, Double), Programmable exposure time and trigger polarity	
External Trigger	External, 3.3 V - 5.0 V, 10 ㎃, optically isolated	
Software Trigger	Camera Link CC1, Programmable Exposure	
Dynamic Range	>62 ㏈	
Control	RS-232C via Camera Link (115.2 K bps)	
Shift Range	0 ~ 15 ㎛, 1 ㎚ step	
Shift Resolution	0.001 ㎛	
Shift Control	Manual Mode or Sequence Mode (4/9 Shot Mono, 4/16/36 Shot Color)	
Shift Latency	< 8 ㎳	
Lens Mount	F-mount	
Power	10~14 V DC, Max. 8 W	10~14 V DC, Max. 12 W
Environmental	Operating: 10℃ ~ 40℃, Storage: -30℃ ~ 65℃	
Mechanical (H × V × D)	90 ㎜ × 90 ㎜ × 123 ㎜, 1.2 kg	

Table 5.4 Specifications of VN Series VN-16M and 29M

5.3 Camera Block Diagram

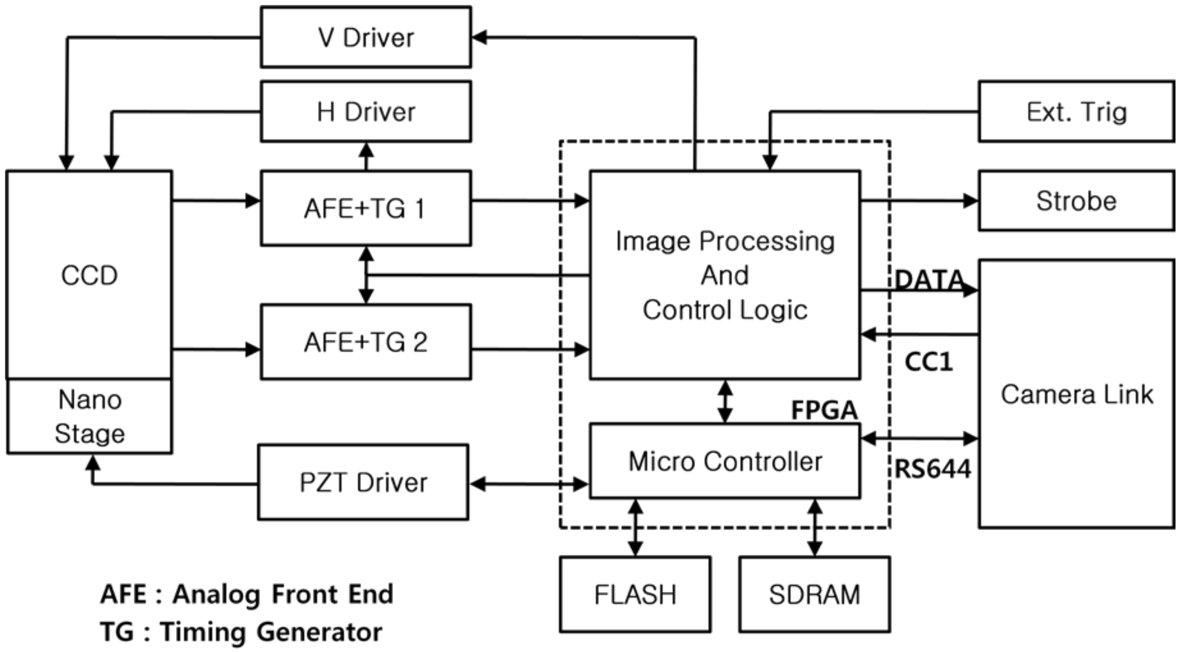


Figure 5.1 VN Camera Block Diagram

All controls and data processing of VN cameras are carried out in one FPGA chip. The FPGA generally consists of a 32 bit RICS Micro-Controller and Processing & Control Logic. The Micro-Controller receives commands from the user through the Camera Link interface and then processes them. The FPGA controls the Timing Generators (TGs) and the Analog Front End (AFE) chips where the TGs generate CCD control signals and AFE chips convert analog CCD output to digital values to be accepted by the Processing & Control Logic. The Processing & Control Logic processes the image data received from AFE and then transmits data through the Camera Link interface. And also, the Processing & Control Logic controls the trigger inputs and strobe outputs which are sensitive to time. Furthermore, SDRAM and FLASH is installed outside FPGA. SDRAM is used for the frame buffer to process images and FLASH contains the firmware that operates the Micro-Controller. And, PZT Driver is applied to control XY Stage with nanometers unit.

5.4 Spectral Response

5.4.1 Mono Camera Spectral Response

The following graphs show the spectral response for VN Camera Link series monochrome cameras.

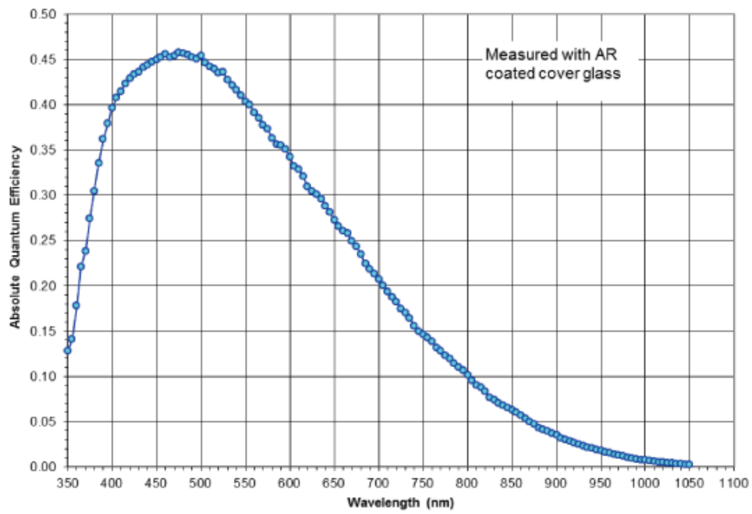


Figure 5.2 VN-8MC-M16 Spectral Response

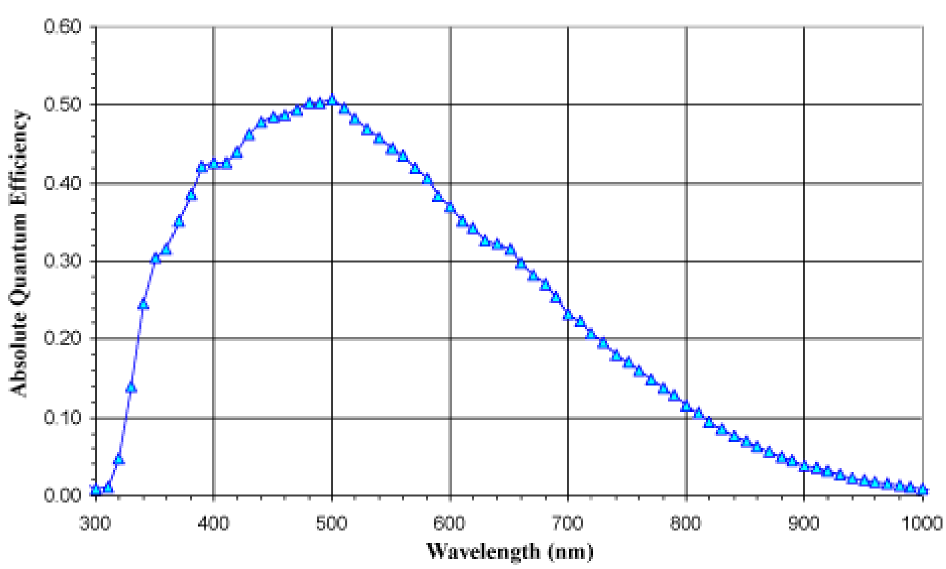


Figure 5.3 VN-11MC-M6 Spectral Response

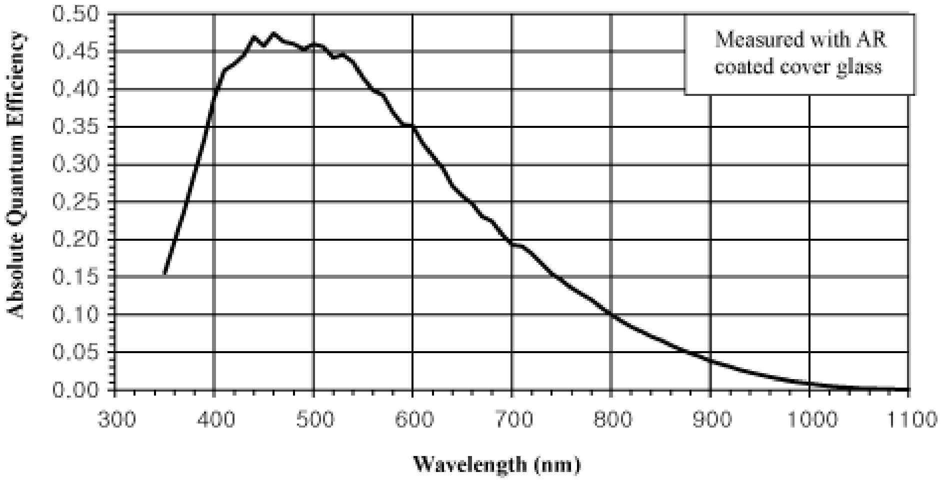


Figure 5.4 VN-16MC-M4 Spectral Response

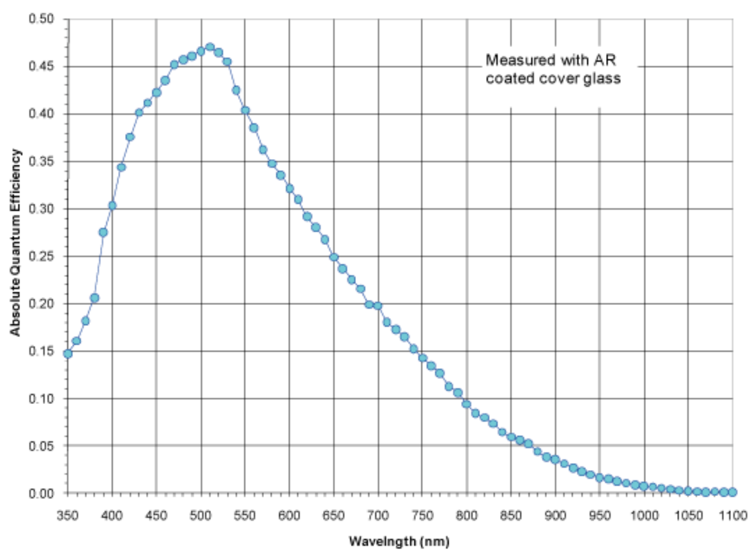


Figure 5.5 VN-29MC-M5 Spectral Response

5.4.2 Color Camera Spectral Response

The following graphs show the spectral response for VN Camera Link series color cameras.

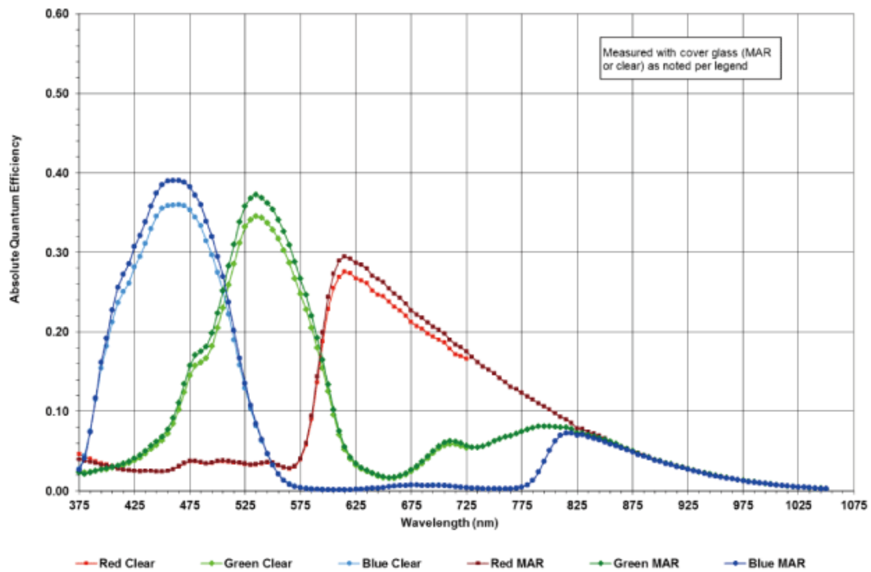


Figure 5.6 VN-8MC-C16 Spectral Response

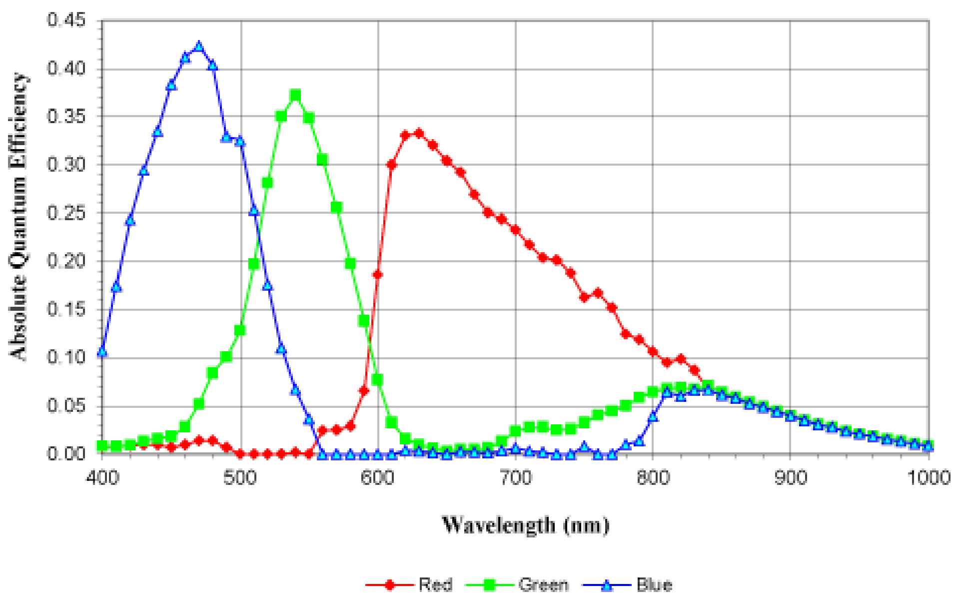


Figure 5.7 VN-11MC-C6 Spectral Response

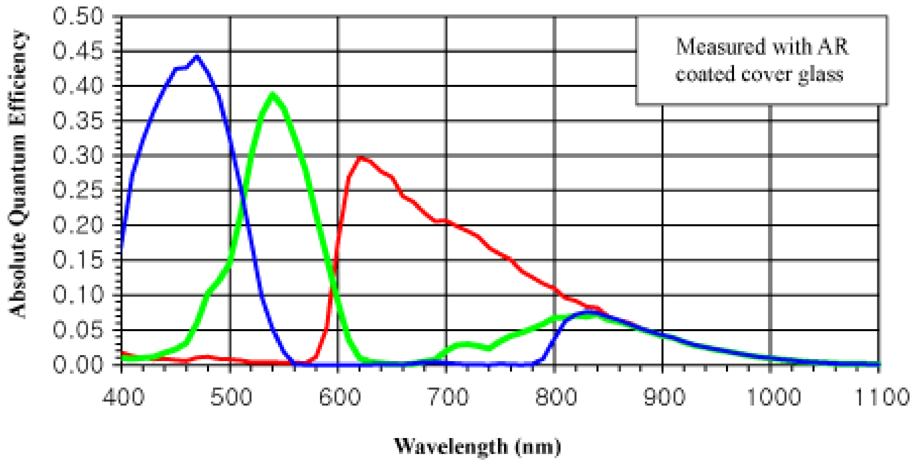


Figure 5.8   VN-16MC-C4 Spectral Response

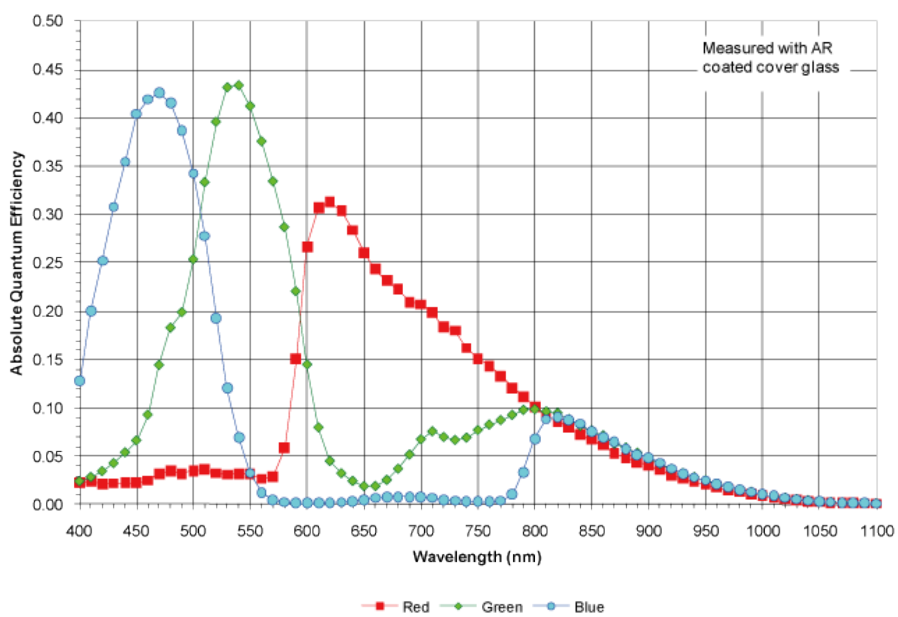


Figure 5.9   VN-29MC-C5 Spectral Response

5.5 Mechanical Specification

The camera's dimensions in millimeters are as shown in the following figure.

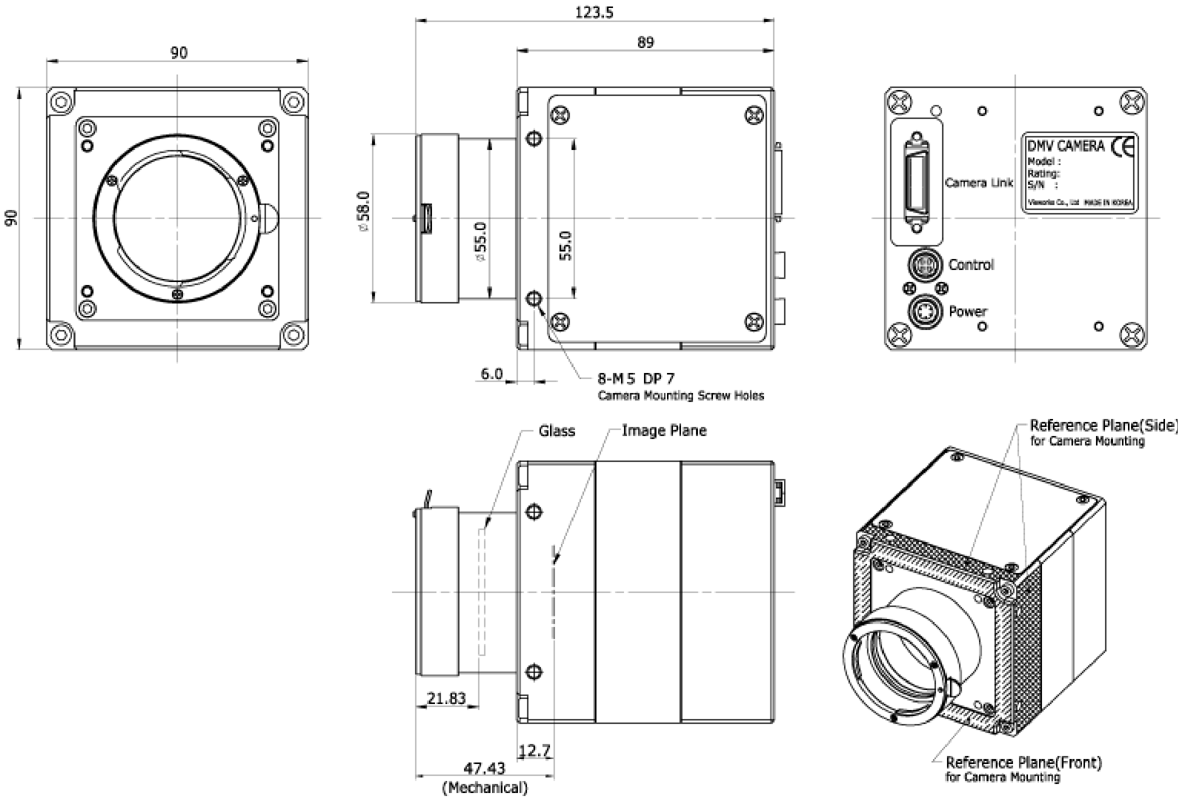


Figure 5.10 VN Camera Mechanical Dimension (F-Mount)

6 Connecting the Camera

The following instructions assume that you have installed a Camera Link frame grabber in your PC including related software. For more information, refer to your Camera Link frame grabber User Manual.

To connect the camera to your PC, follow the steps below:

1 Make sure that the power supply is not connected to the camera and your PC is turned off.

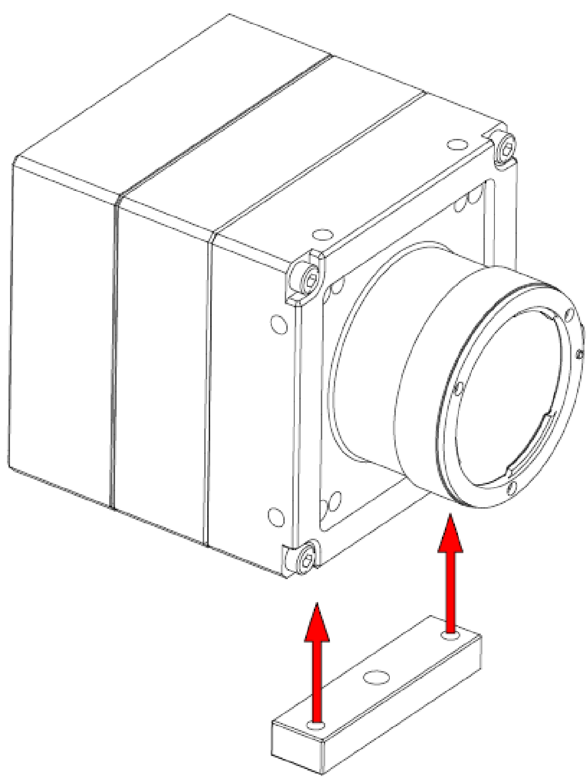
2 Plug one end of a Camera Link cable into the Camera Link connector on the camera and the other end of the Camera Link cable into the Camera Link frame grabber in your PC.

3 Connect the plug of the power adaptor to the power input receptacle on the camera.

4 Plug the power adaptor into a working electrical outlet.

5 Verify all the cable connections are secure.

6.1 Mount Plate



- The Mount Plate is provided as an optional item.
- The camera can be fixed without using this Mount Plate.

6.2 Precaution to center the image sensor

- User does not need to center the image sensor as it is adjusted as factory default settings.
- When you need to adjust the center of image sensor, please contact your local dealer or the manufacturer for technical assistance.

6.3 Precaution about blurring compared to center

- User does not need to adjust the tilt as it is adjusted as factory default settings.
- If the tilt settings need to be adjusted inevitably, please contact your local dealer or factory representative for technical support.

6.4 Installing the Configurator

- You can control the camera by executing the Configurator.exe file.
- You can download the latest Configurator at machinevision.vieworks.com.
- Please refer to your Camera Link frame grabber user manual.

7 Camera Interface

7.1 General Description

As shown in the following figure, 3 types of connectors and status indicator LED are located on the back of the camera and have the functions as follows:

- ① Status LED: displays power status and operation mode.
- ② 26 pin Camera-Link Connector: controls video data transmission and the camera.
- ③ 4 pin Control Connector: inputs external trigger signal and outputs strobe.
- ④ 6 pin Power Input Connector: supplies power to the camera.

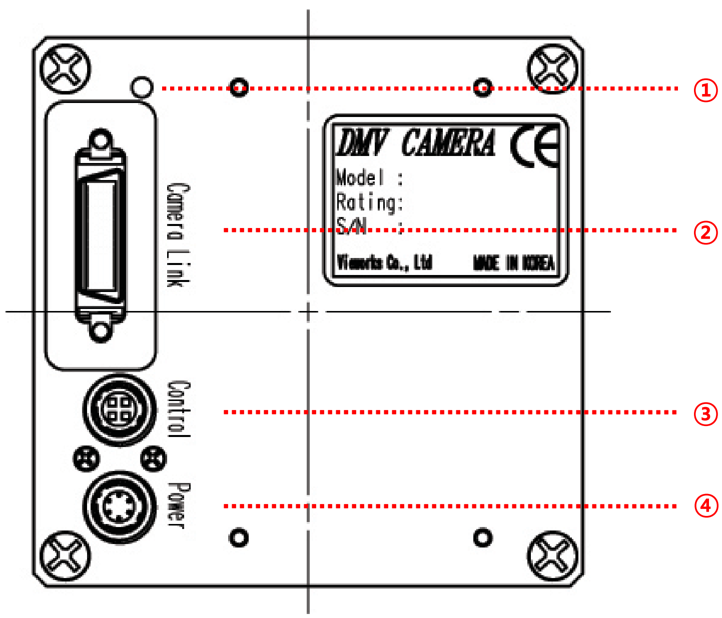


Figure 7.1 VN Series Back Panel

7.2 Camera Link Connector

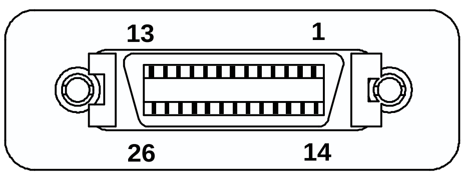


Figure 7.2 Camera Link Connector

Camera Link connector complies with Camera Link Standard and the following list shows the pin configuration of the connector.

PAIR List	Pin	Signal Name	Type	Description
PAIR 0	1	Ground	Ground	Cable Shield
	14	Ground	Ground	Cable Shield
PAIR 1	2	-X0	LVDS - Out	Camera Link Transmitter
	15	+X0	LVDS - Out	Camera Link Transmitter
PAIR 2	3	-X1	LVDS - Out	Camera Link Transmitter
	16	+X1	LVDS - Out	Camera Link Transmitter
PAIR 3	4	-X2	LVDS - Out	Camera Link Transmitter
	17	+X2	LVDS - Out	Camera Link Transmitter
PAIR 4	5	-X3	LVDS - Out	Camera Link Transmitter
	18	+X3	LVDS - Out	Camera Link Transmitter
PAIR 5	6	-XCLK	LVDS - Out	Camera Link Transmitter
	19	-XCLK	LVDS - Out	Camera Link Transmitter
PAIR 6	7	- SerTC	LVDS - In	Serial Data Receiver
	20	+ SerTC	LVDS - In	Serial Data Receiver
PAIR 7	8	- SerTFG	LVDS - Out	Serial Data Transmitter
	21	+ SerTFG	LVDS - Out	Serial Data Transmitter
PAIR 8	9	- CC 1	LVDS - In	Software External Trigger
	22	+ CC 1	LVDS - In	Software External Trigger
PAIR 9	10	N/C	N/C	N/C
	23	N/C	N/C	N/C
PAIR 10	11	N/C	N/C	N/C
	24	N/C	N/C	N/C
PAIR 11	12	N/C	N/C	N/C
	25	N/C	N/C	N/C
PAIR 12	13	Ground	Ground	Cable Shield
	26	Ground	Ground	Cable Shield

Table 7.1 Pin Assignments for Camera Link Base Configuration

7.3 Power Input Connecter

The power input connector is a Hirose 6 pin connector (part # HR10A-7R-6PB). Pin arrangement and configuration are as follows:

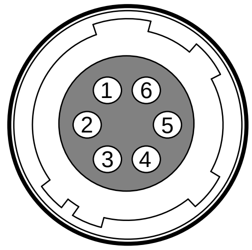


Figure 7.3 Pin Arrangement of Power Input Connector

Pin Number	Signal	Type	Description
1, 2 , 3	+ 12 V DC	Input	DC Power Input
4 , 5 , 6	DC Ground	Input	DC Ground

Table 7.2 Pin Configuration of Power Input Connector

Connecting the power cable to the camera can be made by using the Hirose 6 pin plug (part # HR10A-7P-6S) or the equivalent. The power adaptor is recommended to have at least 1A current output at 12 V DC ±10% voltage output (Users need to purchase the power adaptor separately).

Precaution for Power Input

	• Make sure the power is turned off before connecting the power cord to the camera. Otherwise, damage to the camera may result. • If the camera input voltage is greater than 16 V, damage to the camera may result.

7.4 Control Connecter

The control connector is a Hirose 4 pin connector (part # HR10A-7R-4S) and consists of external trigger signal input and strobe output ports. Pin arrangement and configuration are as follows:

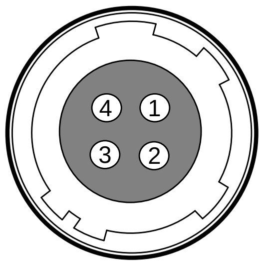


Figure 7.4 Pin Arrangement of Control Connector

Pin Number	Signal	Type	Description
1	Trigger Input +	Input	-
2	Trigger Input -	Input	-
3	DC Ground	-	DC Ground
4	Strobe Out	Output	3.3 V TTL Output Output resistance : 47 Ω

Table 7.3 Pin Arrangement of Control Connector

The mating connector is a Hirose 4 pin plug (part # HR10A-7P-4P) or the equivalent connectors.

7.5 Trigger Input Circuit

Following figure shows trigger signal input circuit of the 4-pin connector. Transmitted trigger signal is applied to the internal circuit through a photo coupler. Minimum trigger width that can be recognized by the camera is 1 ㎲. If transmitted trigger signal is less than 1 ㎲, the camera will ignore the trigger signal. External trigger circuit example is shown below.

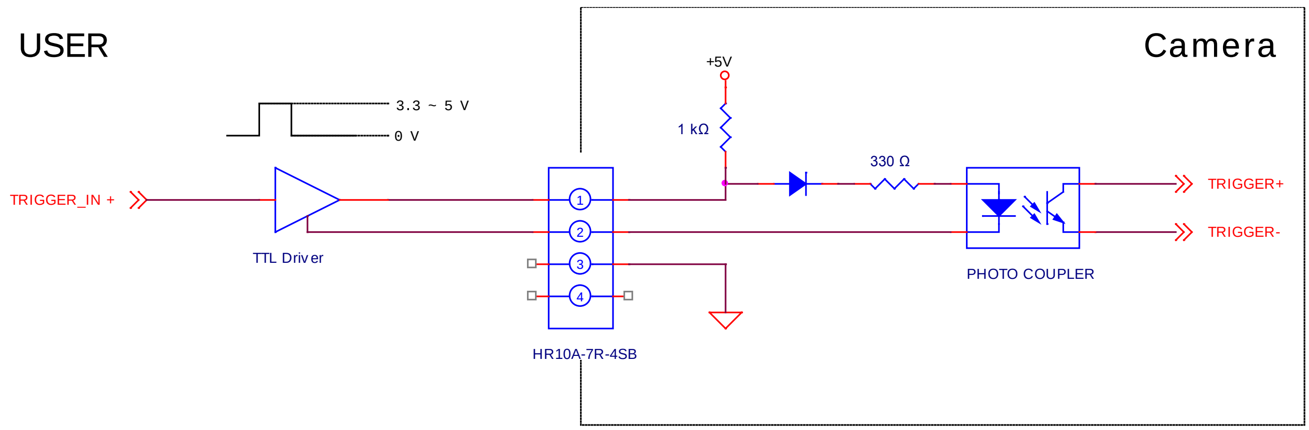


Figure 7.5 Trigger Input Schematic

7.6 Strobe Output Circuit

The strobe output signal is 3.3 V output level of a TTL Driver IC. The pulse width of signal is synchronized with the exposure signal (shutter) of the camera.

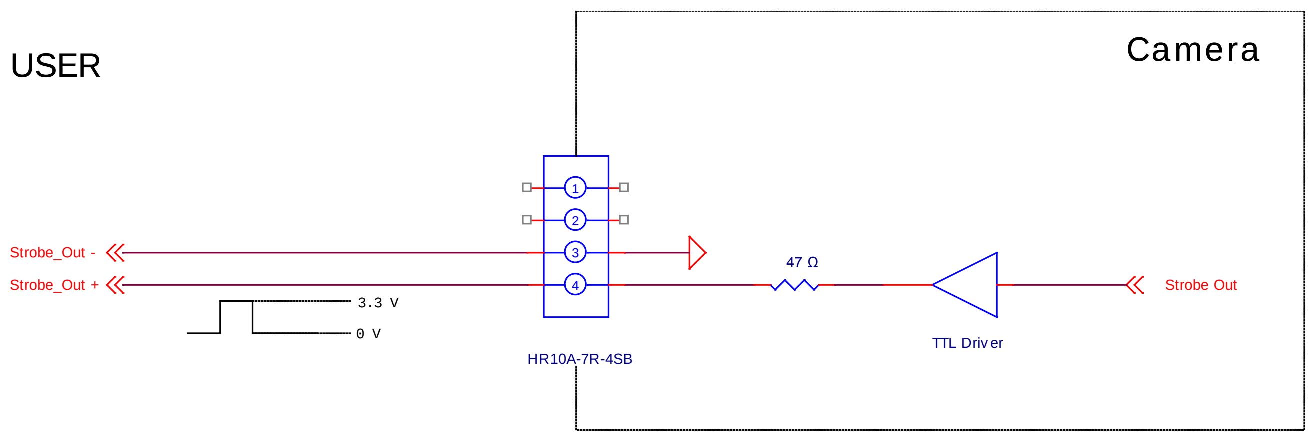


Figure 7.6 Strobe Output Schematic

8 Camera Features

8.1 Area Of Interest (AOI)

The Area of Interest (AOI) feature allows you to specify a portion of the sensor array. You can acquire only the frame data from the specified portion of the sensor array while preserving the same quality as you acquire a frame from the entire sensor array. AOI is determined as the overlapping area of two areas when designating start point and end point in horizontal and vertical direction as shown in the figure below. Start point and End point mean the starting and end of the AOI. According to characteristics of the sensor structure, readout of the image will be proceeded at the top and bottom simultaneously. If the Channel mode is set to 4 Tap and Vertical AOI is applied, V End will be ignored because V End is defined by V Start. The actual V End will be applied according to the following formula:

```
V End = (VSIZE – V Start) - 1
```

The narrower Vertical AOI is designated, the faster the frame speed will be. However Horizontal AOI does not affect frame speed. For more information about AOI parameter settings, see “sha” and “sva” command on Command List.

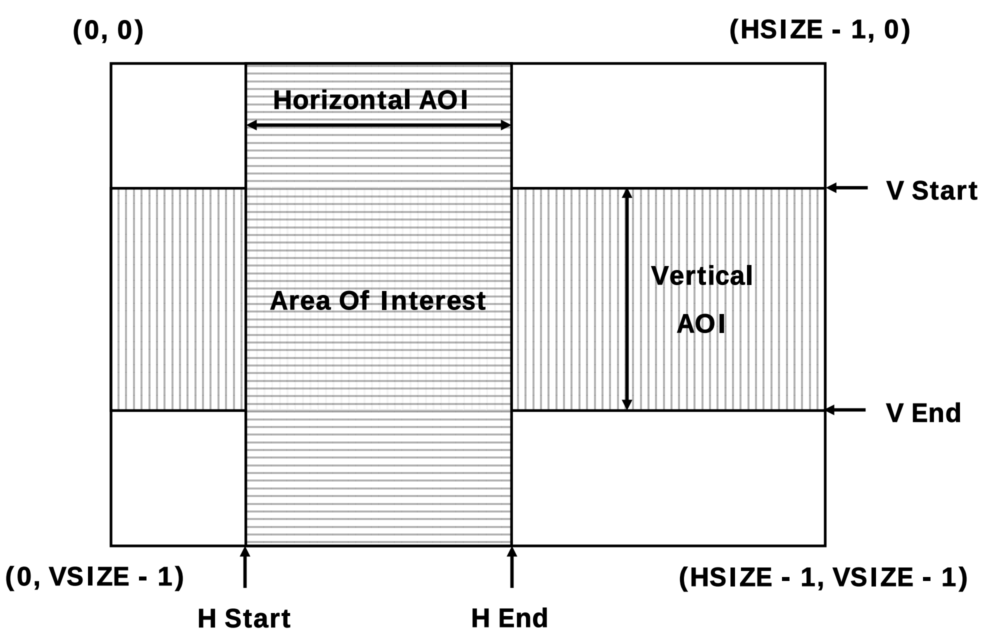


Figure 8.1 AOI

CAUTION	The AOI values (H × V) may vary depending on the type of frame grabber. For technical assistance, contact to your local dealer or the manufacturer.

The maximum frame speed depending on the change of Vertical AOI can be obtained as shown in the following expression.

1 or 2 Channel Mode for **VN-8M & VN-29M**: Frame Rate (fps) = $1000000 / [T_{VCCD} + T_{FD} \times \{V_{SIZE} - (V_{AOI} + 12)\} + (V_{AOI} + 12) \times T_L]$
1 or 2 Channel Mode for **VN-11M & VN-16M**: Frame Rate (fps) = $1000000 / \{T_{VCCD} + T_{FD} \times (V_{SIZE} - V_{AOI}) + V_{AOI} \times T_L\}$
4 Channel Mode for **VN-8M & VN-29M**: Frame Rate (fps) = $1000000 / [T_{VCCD} + T_{FD} \times \{V_{SIZE} - (V_{AOI} + 12)\}/2 + \{(V_{AOI} + 12) \times T_L\}/2]$
T_{VCCD} : time required to move electric charges accumulated on pixel to Vertical Register T_{FD} : time required for Fast Dump V_{SIZE} : number of Vertical Line of CCD T_L : time required for transmission of one line V_{AOI} : size of Vertical AOI

The available minimum value of T_{VCCD}, T_{FD}, V_{SIZE}, T_L and V_{AOI} may vary depending on the camera model. The value of T_L may vary depending on the channel mode. The values of each item depending on the camera model are shown below.

VN Series	VN-8M	VN-11M	VN-16M	VN-29M
TVCCD	17.0 ㎲	190.0 ㎲	242.0 ㎲	56.3 ㎲
TL (1 channel)	90.5 ㎲	106.8 ㎲	135.0 ㎲	172.3 ㎲
TL (2 channel)	46.6 ㎲	55.9 ㎲	73.0 ㎲	90.125 ㎲
TL (4 channel)	46.6 ㎲	-	-	90.125 ㎲
TFD	4.1 ㎲	6.0 ㎲	16.0 ㎲	6.8 ㎲
V_{SIZE}	2520 Lines	2672 Lines	3248 Lines	4384 Lines
Minimum Vertical AOI Size	300 Lines	334 Lines	406 Lines	500 Lines

Table 8.1 Timing Value for VN Series

The following figure shows frame rate depending on VAOI changes.

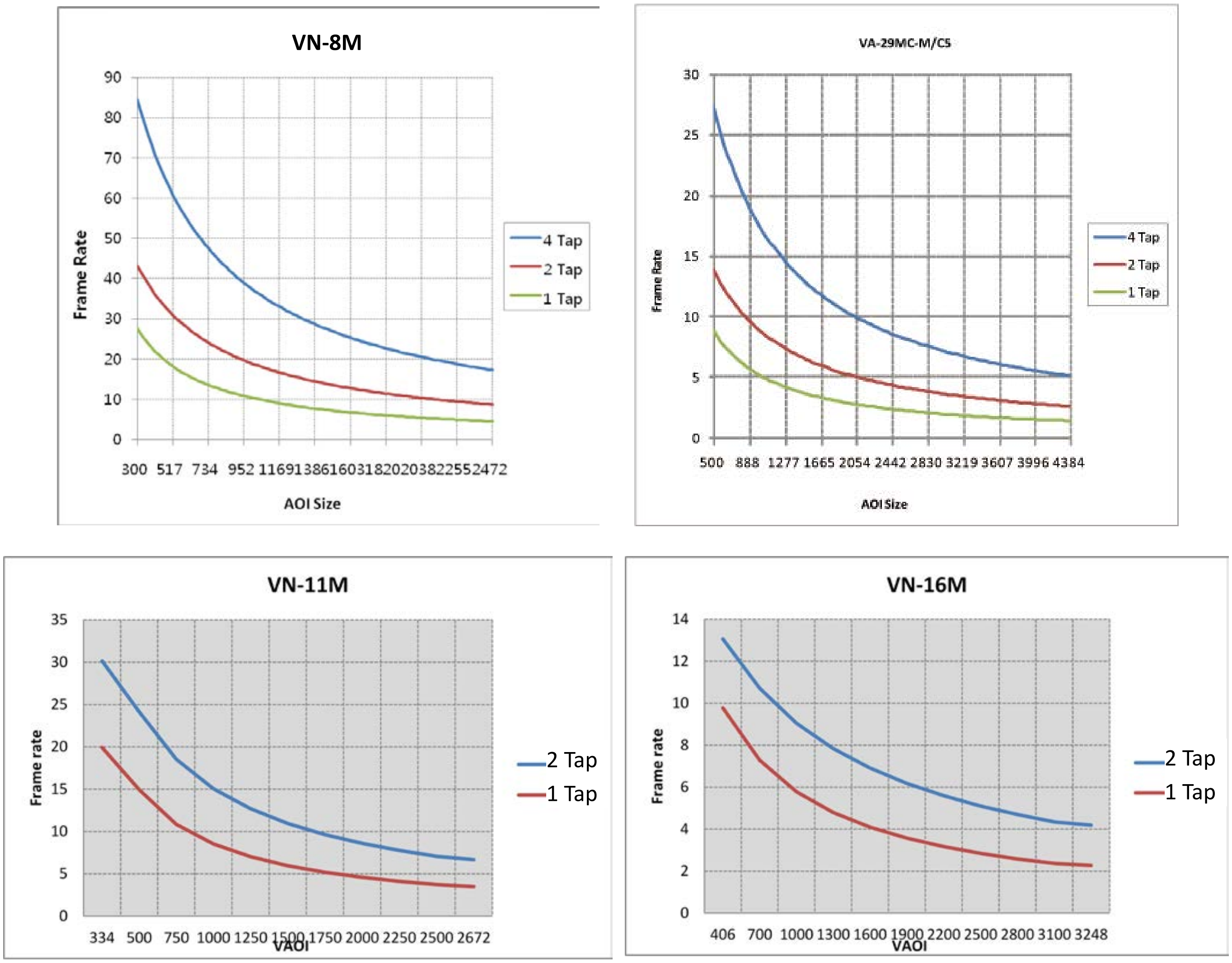


Figure 8.2 Frame Rate by VAOI changes

8.2 Binning

Binning has the effects of increasing the level value and decreasing resolution by adding the values of the adjacent pixels and sending them as one pixel. The camera applies same Binning Factor (2 or 4) to both directions in order to keep the percentage of image. The below figure shows application of 2 × 2 Binning and 4 × 4 Binning respectively. Since Binning in vertical direction is processed at internal register of CCD, the frame speed increases as many as Binning Factor if Binning is applied, but Binning in horizontal direction does not affect frame speed. Binning Factor is set using “sbf” command.

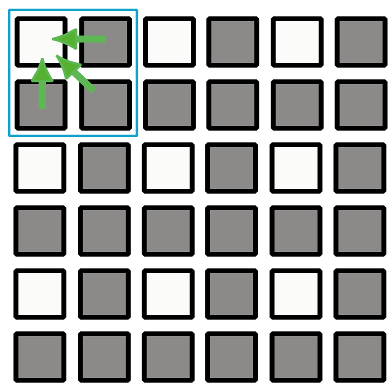


Figure 8.3 2 × 2 Binning

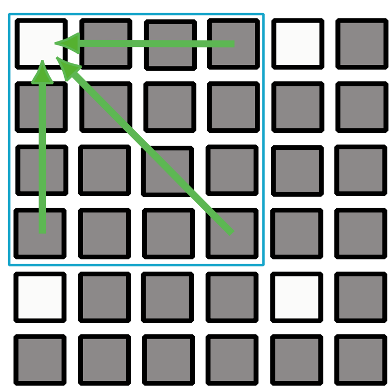


Figure 8.4 4 × 4 Binning

CAUTION	Even if the binning is performed on the color camera, the resulting image will be monochrome.

8.3 Trigger

8.3.1 Trigger Input

Trigger mode of the camera is divided into Trigger synchronous mode and Trigger asynchronous mode (hereinafter "Free-Run mode") depending on its synchronization with trigger input. Trigger synchronous mode is divided into Standard mode, Double Exposure mode, Fast mode, Overlap mode, depending on concrete operation type.

It is required to set the trigger first to operate the camera in Trigger synchronous mode. In concrete, it is required to select which one of CC1 port and TRIGGER_IN port should be used as trigger input and to set whether polarity of trigger should be Positive or Negative.

8.3.1.1 Free-Run Mode

Free-Run Mode repeats Readout depending on parameter value set in the camera currently, regardless of trigger input.

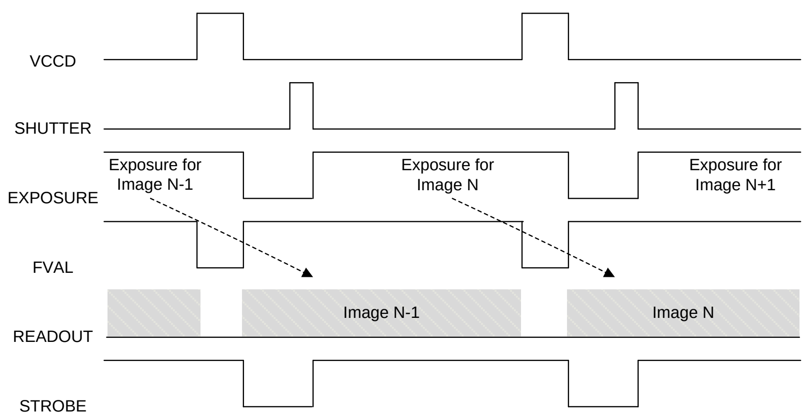


Figure 8.5 Free-Run Mode

As shown in the above figure, Readout section overlaps with exposure section of next image in Free-Run Mode. At this time, the camera operation slightly differs depending on length of Exposure Time and Readout time. If Exposure Time is shorter than Readout, Shutter signal occurs during readout, and when Readout finishes, Readout of next image starts (Figure 8.6). In this case, frame speed is constant regardless of change in Exposure Time. But if Exposure Time is set longer than Readout time, Shutter signal occurs together with start of Readout and Readout of next image does not start until Exposure Time set elapses even if Readout finishes (Figure 8.7). In this case, frame speed gets lower as the setting value of Exposure Time increases.

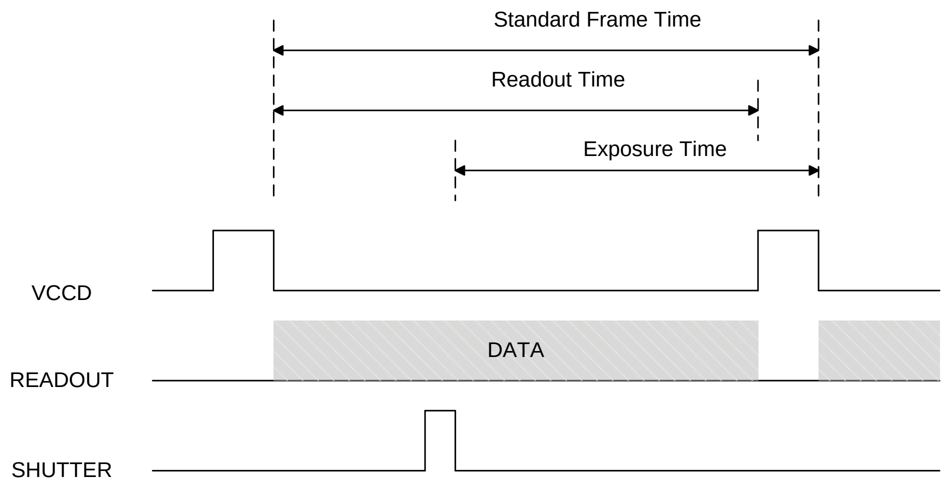


Figure 8.6 Exposure Time is Shorter than Readout Time

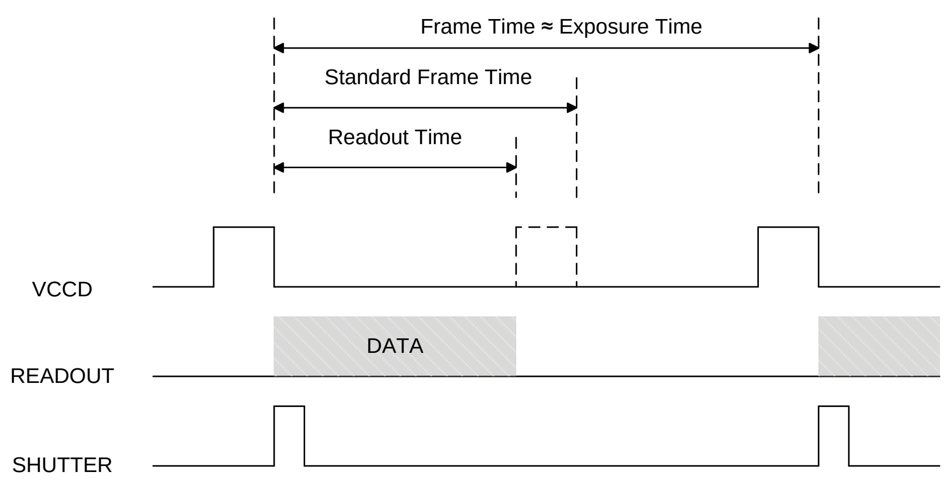


Figure 8.7 Exposure Time is longer than Readout Time

8.3.1.2 Standard Mode

In Standard Mode, the camera keeps standby status until trigger signal is entered, and when trigger input occurs, Readout start after Exposure process set earlier. After Readout is completed, and returns to trigger standby status again. In Standard Trigger mode, if a new trigger input occurs during readout, the new trigger input is ignored.

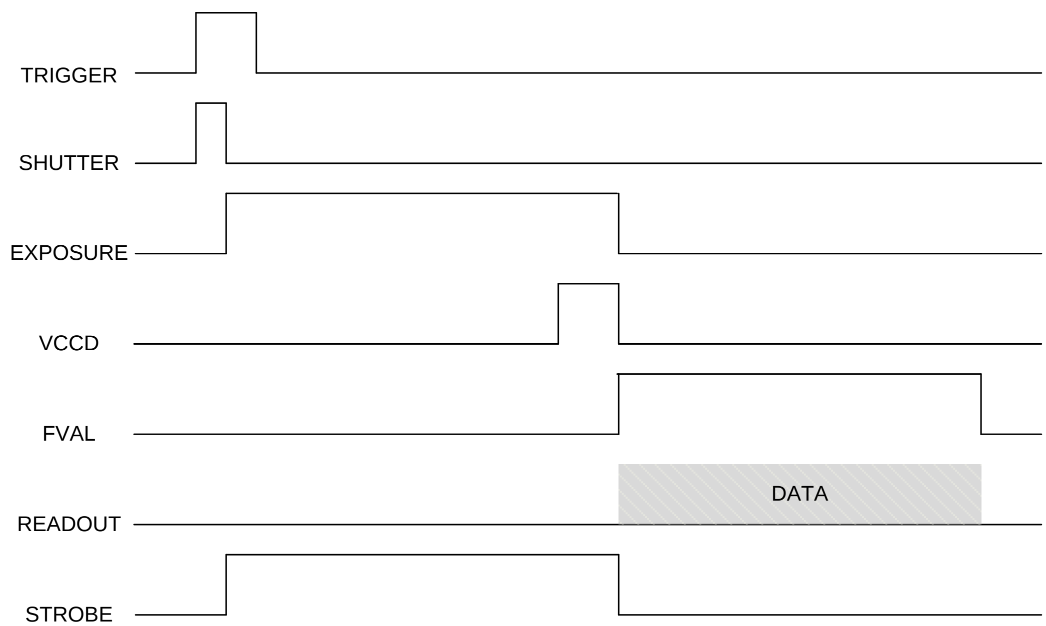


Figure 8.8 Standard Trigger Mode

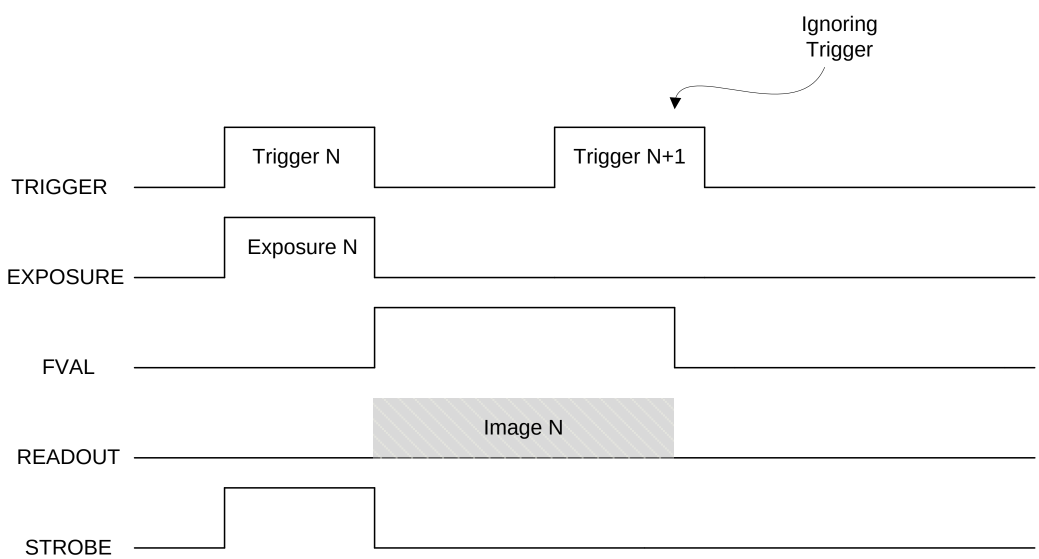


Figure 8.9 Retriggering

8.3.1.3 Double Exposure Mode

In Double Exposure mode, 2 images are obtained with 1 trigger input. When trigger input is entered in this mode, the camera starts Readout after passing through exposure process according to exposure setting as in Standard mode. At this time, exposure of second image starts with Readout. When Readout is completed, the camera performs the second Readout. Since it does not generate shutter signal during Readout of the 1st image, the interval between completion of 1st exposure and starting of 2nd exposure is as short as several ㎲ ~ several decades ㎲.

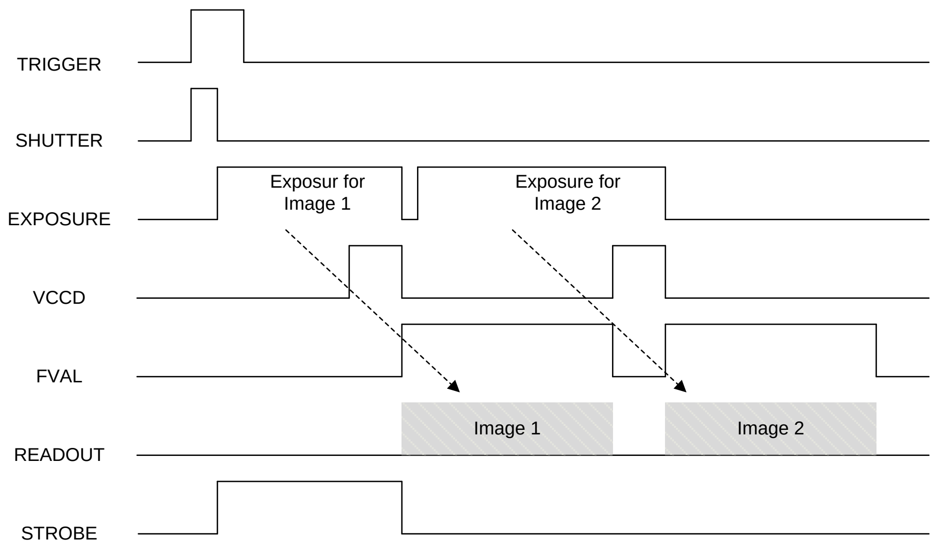


Figure 8.10 Double Exposure Trigger Mode

8.3.1.4 Fast Mode

Fast Mode is used when interval of trigger input is faster and more continuous than in Standard Mode. Its difference from Standard Mode is that while Readout starts in exposure time as set earlier when trigger input occurs in Standard Mode, while Readout immediately starts after trigger input in Fast Mode. And Interval between triggers becomes the exposure time of image since it does not generate shutter signal during Readout.

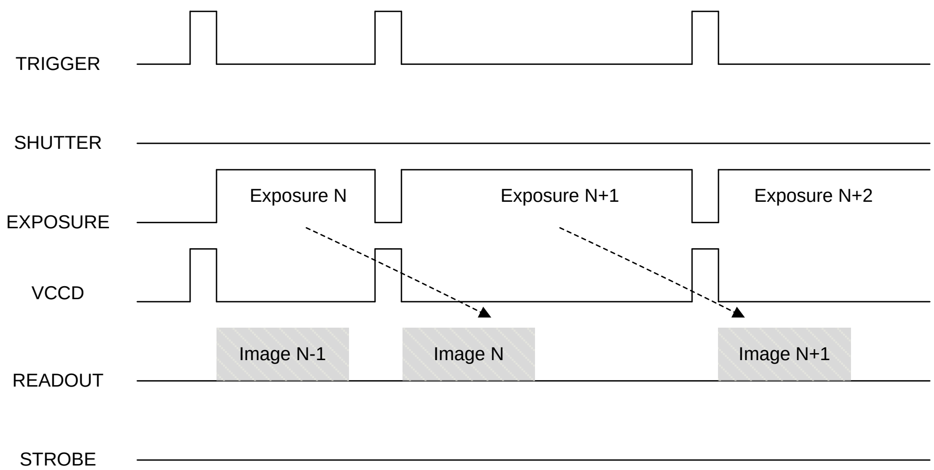


Figure 8.11 Fast Trigger Mode

8.3.1.5 Overlap Mode

The camera keeps standby status until trigger signal is entered like in Standard Mode, and Readout starts after exposure process set earlier if trigger input occurs. When new trigger input occurs during Readout of First image, it keeps Readout and pass exposure process of new trigger input. Provided, however, that when trigger input occurs during Exposure since Exposure Time is longer than trigger interval, that trigger signal is ignored. To obtain the image as maximum frame for trigger input, Exposure Time should not be longer than Readout time, trigger time should not be shorter than Readout time.

Channel Mode	VN-8M	VN-11M	VN-16M	VN-29M
1 channel	226.5 ㎳	294.1 ㎳	454.5 ㎳	763.1 ㎳
2 channel	121.9 ㎳	156.2 ㎳	238.1 ㎳	397.7 ㎳
4 channel	61.3 ㎳	-	-	199.6 ㎳

Table 8.2 Readout Time for each model

In addition, overlap mode operates ideally when trigger signal interval or exposure time is constantly kept.

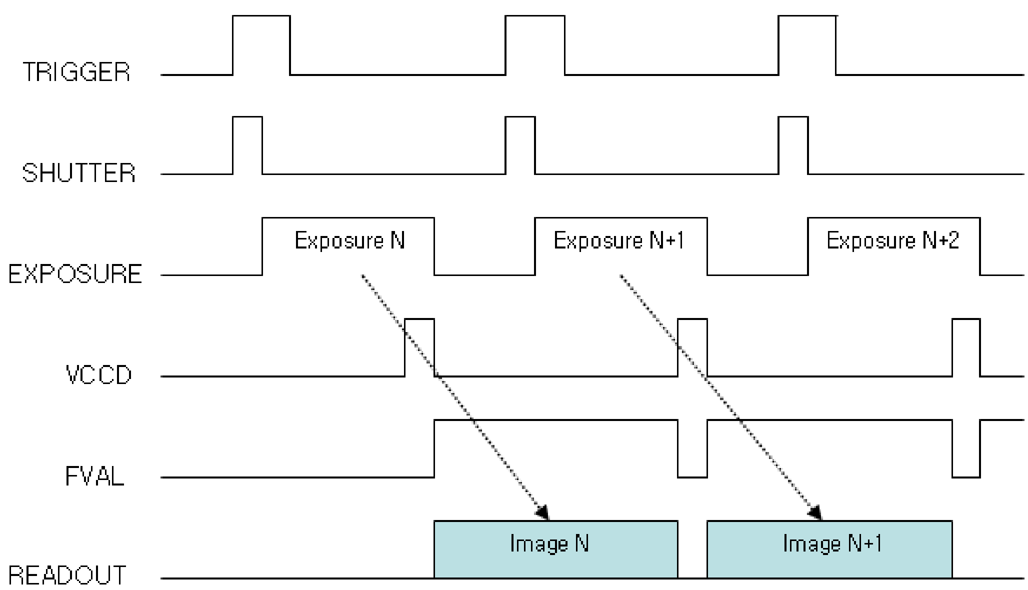


Figure 8.12 Overlap Trigger Mode

8.4 Channel Mode

Accumulated charges are read out of the sensor when exposure ends. The sensor can be read out in one tap (single channel), two tap (dual channel) or four tap (quadrant channel - VN-8MC only). In case of one tap output, all pixel values of Horizontal Register are shifted towards the left bottom Video Amplifier (Video A). In case of two tap output, pixel values from left to the center of Horizontal Register are shifted towards the Video A, and pixel values from the right are shifted towards the Video B. In case of four tap output (VN-8MC), pixel values of the lower left area are shifted towards the Video A, pixels values of the lower right area are shifted towards the Video B, pixel values of the upper left area are shifted towards the Video C, and pixel values of the upper right area are shifted towards the Video D. The advantage of four tap output is that it makes readout about 4 times faster than one tap output.

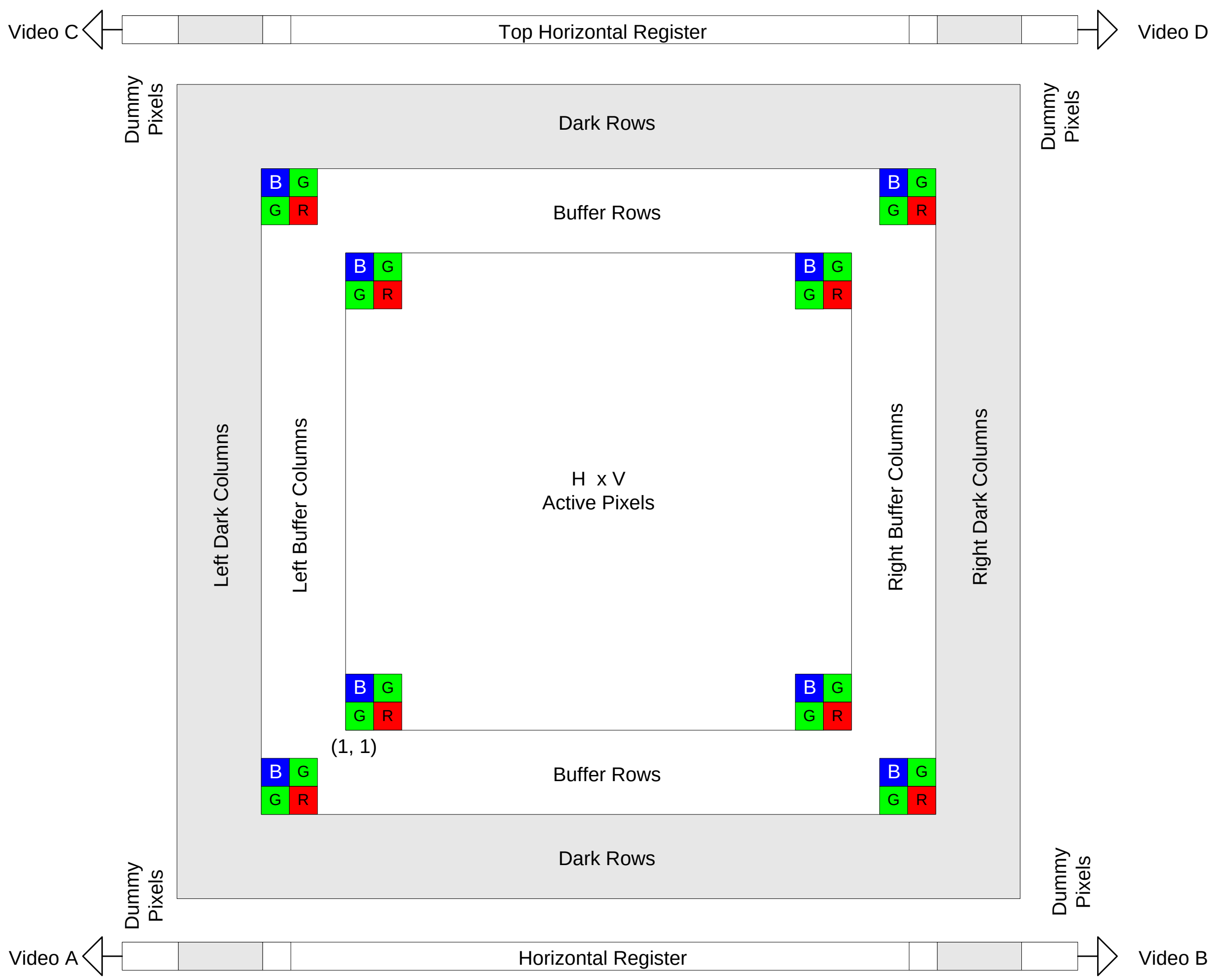


Figure 8.13 Channel Mode

The camera processes and rearranges the image data in order to be compliant with the base Camera Link Standard. In single channel, image data is read out line-by-line from the upper left corner until the last pixel in the lower right corner is read out. In dual channel, image data is read out of Channel A and B simultaneously in interleaved order. In quadrant channel (VN-8MC), image data which is transmitted from Video A, B, C and D simultaneously, is read out of the top half and the bottom half in interleaved order (Figure 8.15).

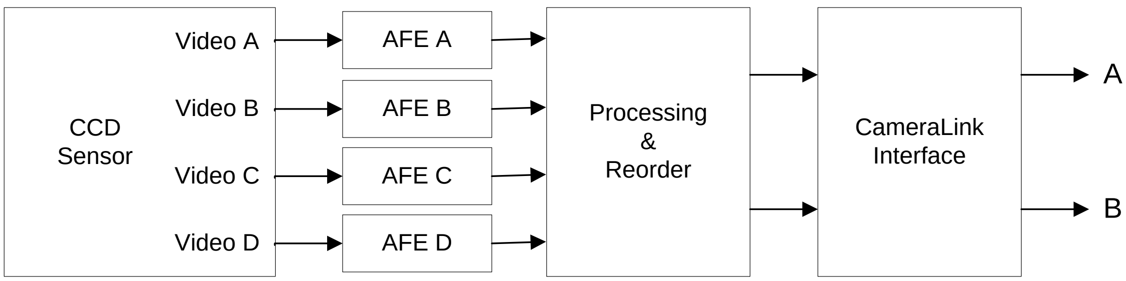


Figure 8.14 Image Data Flow

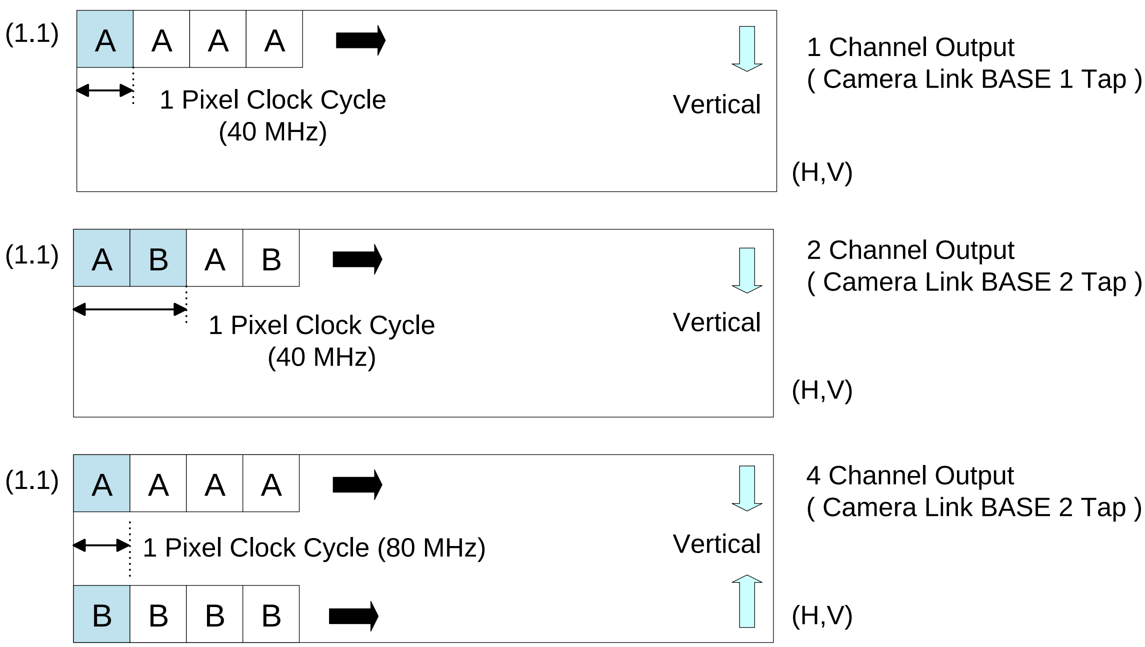


Figure 8.15 Data Output

8.5 Gain and Offset

The camera has one Analog Signal Processor (or Analog Front End, abbreviated to AFE) for each channel. This AFE consists of Correlated double Sampler (CDS), Variable Gain Amplifier (VGA), Black Level Clamp and 12-bit A/D converter. AFE has register for Gain and Offset application inside, and can change Gain and Offset value by entering proper value in the register. Gain can be set between 0 ~ 899. The relationship between setting value and actual Gain (㏈) is as follows:

```
Gain(㏈) = (Setting value × 0.035 ㏈)
```

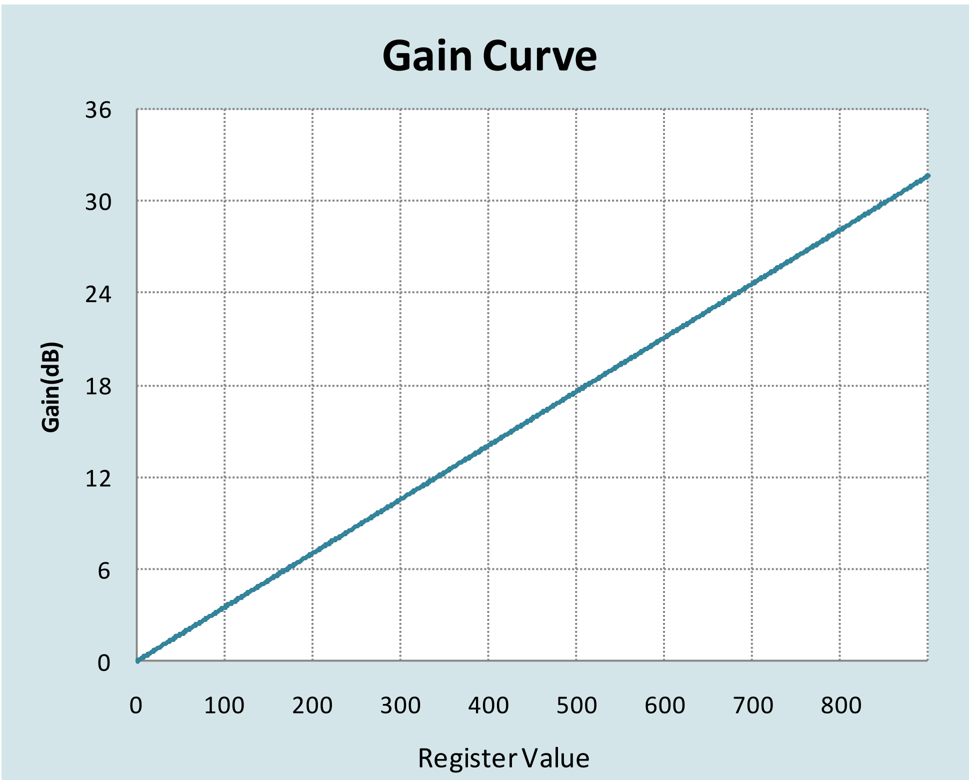


Figure 8.16 Register Setting for Gain Value

Offset can be set between 0 ~ 255 (LSB).

8.6 LUT

LUT (Lookup Table) converts original image value to certain level value. Since it is mapped one to one for each level value, 12-bit output can be connected to 12-bit input. LUT is in the form of table that has 4096 entries between 0~4095 and provides 2 non-volatile spaces for LUT data storage. User can select whether to apply LUT or not and where to apply the LUT using “sls” command. See Appendix B for how to download LUT data in the camera.

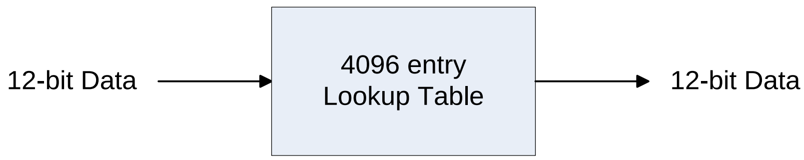


Figure 8.17 LUT Block

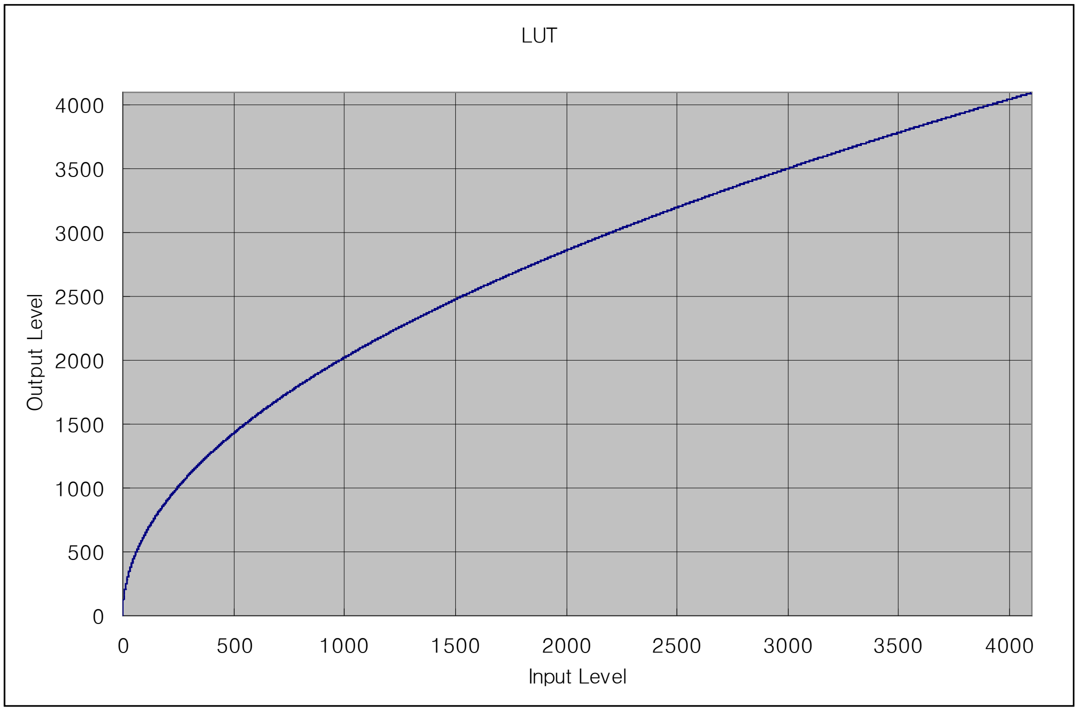


Figure 8.18 LUT at Gamma 0.5

8.7 Defective Pixel Correction

The CCD may have Defect Pixels which cannot properly react to the right. Correction is required since it may deteriorate the quality of output image. Defect Pixel information of CCD used for each camera is entered into the camera during the manufacturing process. If you want to add Defect Pixel information, it is required to enter coordinate of new Defect Pixel into the camera.

For more information, refer to Appendix A. “sdc” command is used to set whether to use Defective Pixel Correction feature.

8.7.1 Correction Method

Correction value of a Defect Pixel is calculated based on valid pixel value adjacent in the same line.

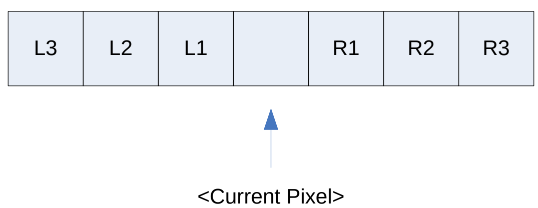


Figure 8.19 Location of Defect Pixel to be corrected

If Current Pixel is a Defect Pixel as shown in the above figure, correction value of this pixel is obtained as shown in the following table depending on whether surrounding pixel is Defect Pixel or not.

Adjacent Defect Pixel(s)	Correction value of Current Pixel
None	(L1 + R1) / 2
L1	R1
R1	L1
L1, R1	(L2 + R2) / 2
L1, R1, R2	L2
L2, L1, R1	R2
L2, L1, R1, R2	(L3 + R3) / 2
L2, L1, R1, R2, R3	L3
L3, L2, L1, R1, R2	R3

Table 8.3 Calculation of Defect Pixel Correction Value

8.8 Flat Field Correction

The Flat Field Correction feature improves the image uniformity when you acquire a non-uniformity image due to external conditions. The Flat Field Correction feature can be summarized by the following equation:

```
IC = {(IR – IB) × M } / (IF – IB)

Where,
IC : Level value of corrected image;
IR : Level value of original image;
IB : Black offset value;
M : Offset value of image after correction;
IF : Level value of Flat Field data.
```

In order to use the Flat Field Correction function, one must first generate IF, the Flat Field data. This can be done by adjusting the camera to the environment and activating the Flat Field Generator. The Flat Field Generator will standardize a series of images, curtailing the image to 1/16 pixel, generate the curtailed Flat Field data, and store it in the external frame buffer. When curtailed images are used for corrections, it is expanded and applied with a Bilinear Interpolation as shown in Figure 8.21. When the Flat Field data is generated, use the "sfo" command to set the M value, and use the "sfc" command to apply the Flat Field Correction. Here, the Flat Field data is stored on the RAM, a volatile memory. In order to reuse the stored data, the "sdf" command must be used to store them on the FLASH, a non-volatile memory.

CAUTION	1. The activation of the Flat Field Generator will ignore the current camera configuration and will temporarily change the camera configuration to operate under the following default conditions. When the generation of the Flat Field data is complete, the original setting of the camera will be restored. • Readout Mode : Normal • Trigger Mode : Free-Run • Channel Mode : Single • Defective Pixel Correction : ON 2. The offset value M is based on the Normal Readout mode. According to the AOI mode, Binning mode, or Dual Channel mode, the offset value of an actual image is expressed differently.

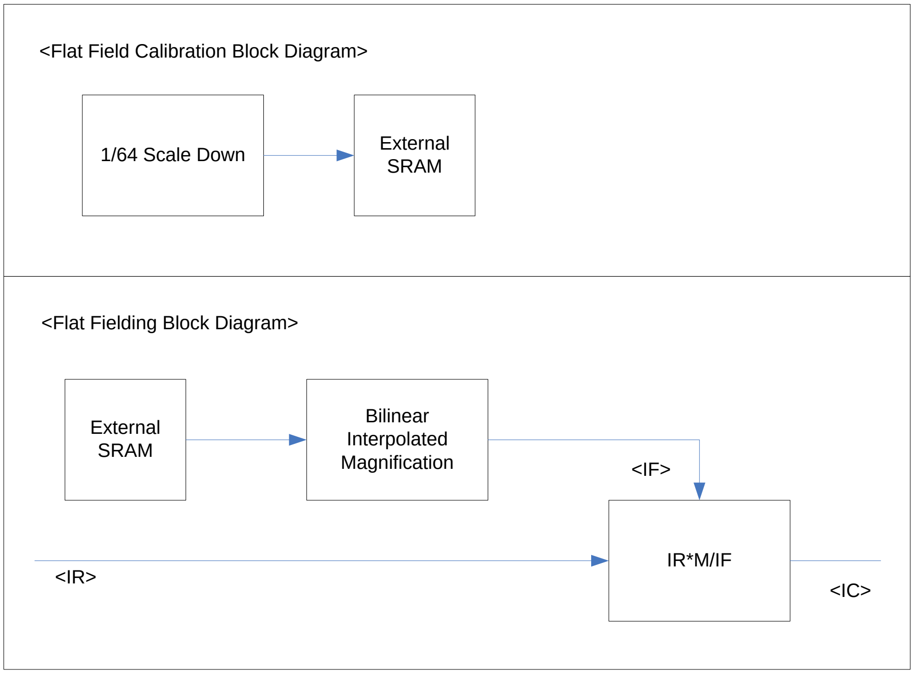


Figure 8.20 Generation and Application of Flat Field Data

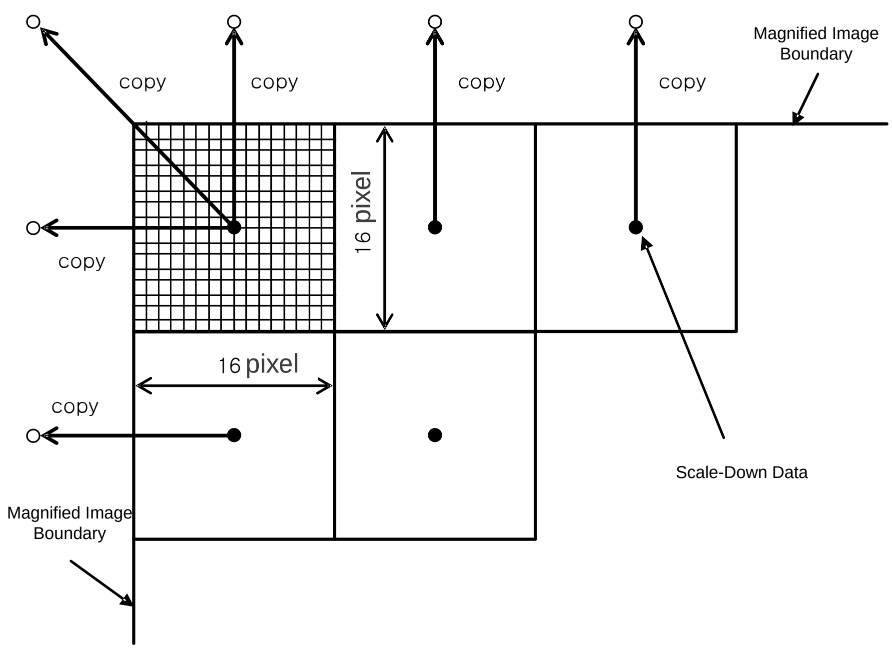


Figure 8.21 Bilinear Interpolated Magnification

8.9 Dark Signal Non-uniformity Correction (VN-8M/29M Only)

In theory, when an area scan camera captures a frame in complete darkness, all of the pixel values in the frame should be near zero and they should be equal. In practice, however, slight variations in the performance of the pixels in the sensor will cause some variations in the pixel values output from the camera when the camera is capturing in darkness. This variation is known as Dark Signal Non-uniformity (DSNU). The VN-8M and VN-29M models provide the DSNU Correction feature. “sdsnu” command is used to set whether to use the DSNU correction feature.

CAUTION	When you enable the **DSNU** Correction feature, you cannot acquire frames at the camera’s nominal maximum frame rate. • This is true because the camera takes time (milliseconds) to apply the DSNU Correction feature after reading out the pixel values. • When you acquire frames using the CC1 or external triggering, you must consider the triggering cycle properly.

8.10 Temperature Monitor

Sensor chip is embedded in the camera to monitor the internal temperature. “gct” command is used to check the temperature of camera.

8.11 Status LED

There is green LED to inform the operation status of camera on the back of camera. LED status and corresponding camera status are as follows:

• Continuous ON	operates in Free-Run Mode.
• Repeat ON for 0.5 seconds, OFF for 0.5 seconds:	operates in Trigger Mode.
• Repeat ON for 1 second, OFF for 1 second:	outputs Test Image.
• Repeat ON for 0.25 second, OFF for 0.25 second:	operates in Trigger Mode and outputs Test Image.

8.12 Pixel Shift

The Pixel Shift camera shifts the image sensor to X and Y direction precisely with 1/2 or 1/3 pixel distance using 2D-Stage. The resulting image can be combined of 4 individual images captured by shifting the image sensor to X and Y direction with 1/2 pixel distance as shown in the figure below. Thus, the output image offers improved resolution (4 shot result image) in comparison with standard output image (1 shot result image). Combining the images should be done on the PC side with software processing. Please contact local dealer or factory representative for the details on the sample software combining the images.

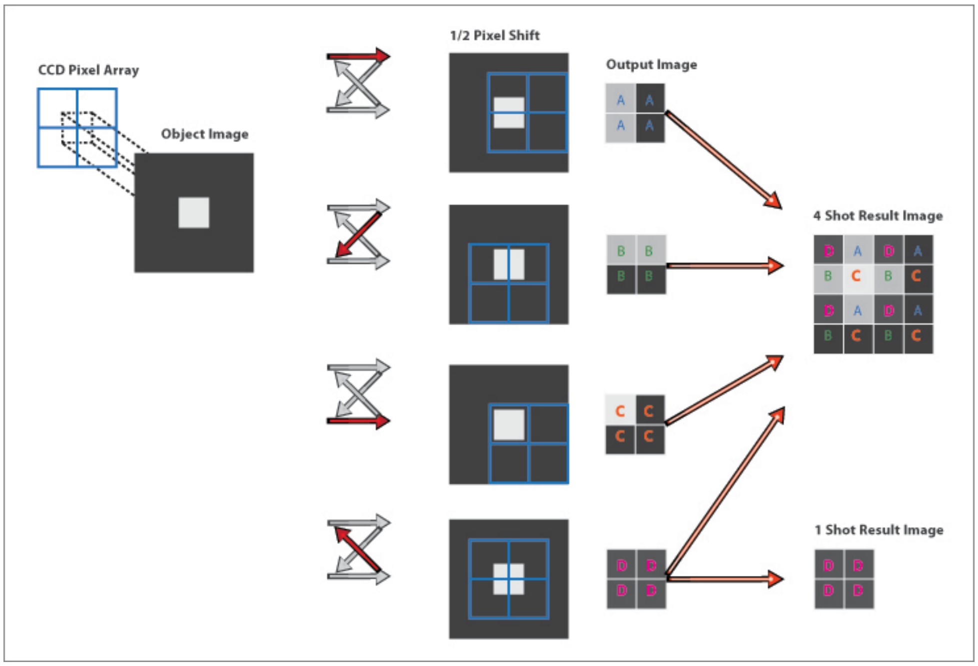


Figure 8.22 1/2 Comparison of resolution between Pixel Shift camera and standard camera

- The camera contains components sensitive to heat, shock, or vibration. Handle this camera with the maximum care. Operate the camera at temperature between 10℃ and 40℃.
- Due to a temperature difference between the product and environment, moisture may condense inside or outside the camera. This moisture condensation may cause a malfunction of the camera or shorten the product life cycle. If some condensation occurs, turn off the camera and wait about an hour for the moisture to evaporate.

8.12.1 Pixel Shifting and True Color resolution

One benefit of pixel shifting technology in comparison to fixed sensor cameras is its ability to acquire more than 4 times higher resolution than the fixed one. The below figure shows standard output image and ×9 shifting output image. In case of VN-11MC camera model, the output image will have 12,024 × 8,016 (99 Megapixel) resolution if the pixel shifting is applied. Otherwise, the resolution of output image is 4,008 × 2,672 (11 Megapixel) without the pixel shifting.

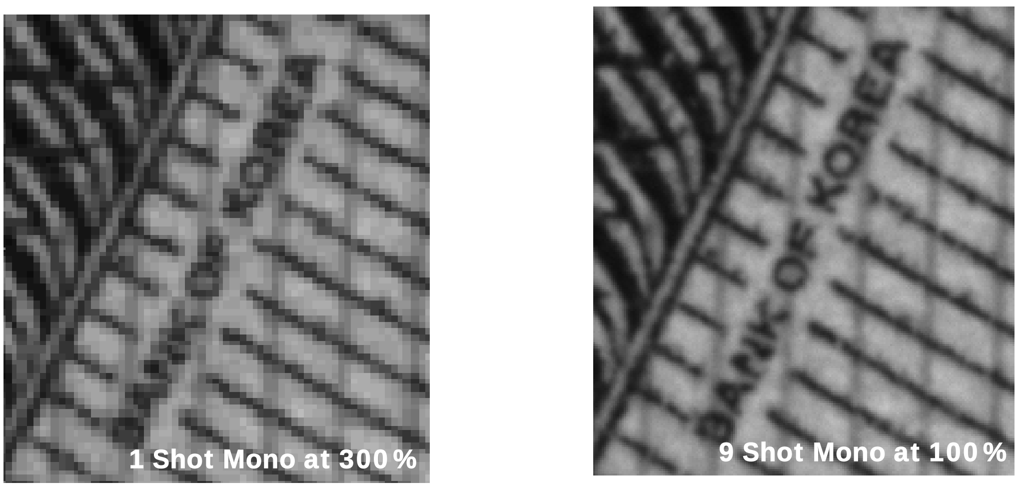


Figure 8.23 Standard (left) vs 9 Shot Pixel Shifting (right)

Another benefit of pixel shifting technology compared to fixed CCDs is acquiring True Color image. Currently CCD cameras use Bayer Interpolation to produce color images so that unwanted artifacts can occur such as color moiré or false color pixels. Using pixel shifting, no color artifacts or aliasing will occur and the color resolution is optimized.

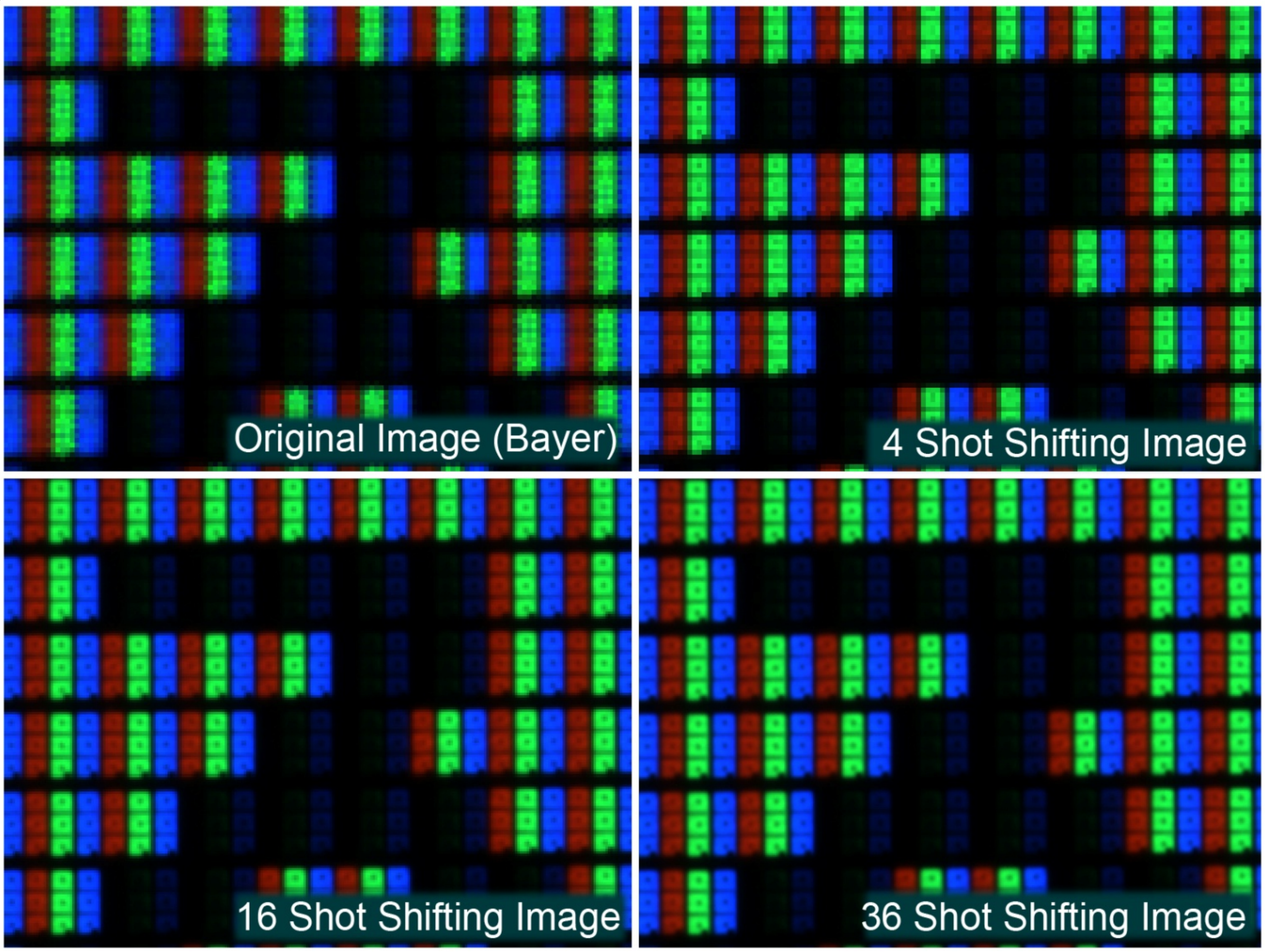


Figure 8.24 Standard Image Color vs Shifting Image Color

CAUTION	Use VN Series camera where subjects are fixed and lighting environment is constant.

8.12.2 Sequence Mode

8.12.2.1 Components of Sequence Mode

Sequence Mode can be set with following options.

- 0. None (Manual)
- 1. 4 Shot Mono (Doubled vertical and horizontal resolution)
- 2. 9 Shot Mono (Tripled vertical and horizontal resolution)
- 3. 4 Shot Bayer Color (Full color resolution)
- 4. 16 Shot Bayer Color (Full color resolution, doubled vertical and horizontal resolution)
- 5. 36 Shot Bayer Color (Full color resolution, tripled vertical and horizontal resolution)

8.12.2.2 Operation of Sequence Mode

In 1 – 6 sequence modes where the position of the stage has been predefined, the sequence operates by applying only trigger signal. The default position of the stage is (0, 0) and the following position will vary depending on the sequence mode. Once one cycle of operation has completed, the stage position returns to (0, 0). When the camera is running in Free-Run mode, the sequence mode will be deactivated because the sequence mode is synchronized only with external Trigger or CC1 Trigger. Refer to Appendix D for the position settings according to sequence modes.

None (Manual) mode is useful when the sequence and stage position need to be configured manually. The user can configure the stage position using “snp” serial command.

When the user controls the stage using serial command manually, it takes about 16 ㎳ from sending the command to shifting the stage. This period includes latency of serial communication and shifting time of the stage. Actually, it takes 8 ㎳ for the stage to be shifted.

To operate correctly in None (Manual) mode, the user needs to calculate the trigger timing considering frame transfer and stage setup time, and then applies the trigger signal to the camera. The minimum trigger period can be obtained as shown in the following expression:

- When sum of exposure time and stage setup time is shorter than frame transfer time:
  (Frame Transfer Time > Exposure Time + Stage Setup Time)
  - **Minimum Trigger Period = Frame Transfer Time**
- When sum of exposure time and stage setup time is longer than frame transfer time:
  (Frame Transfer Time < Exposure Time + Stage Setup Time)
  - **Minimum Trigger Period = Exposure Time + Stage Setup Time**

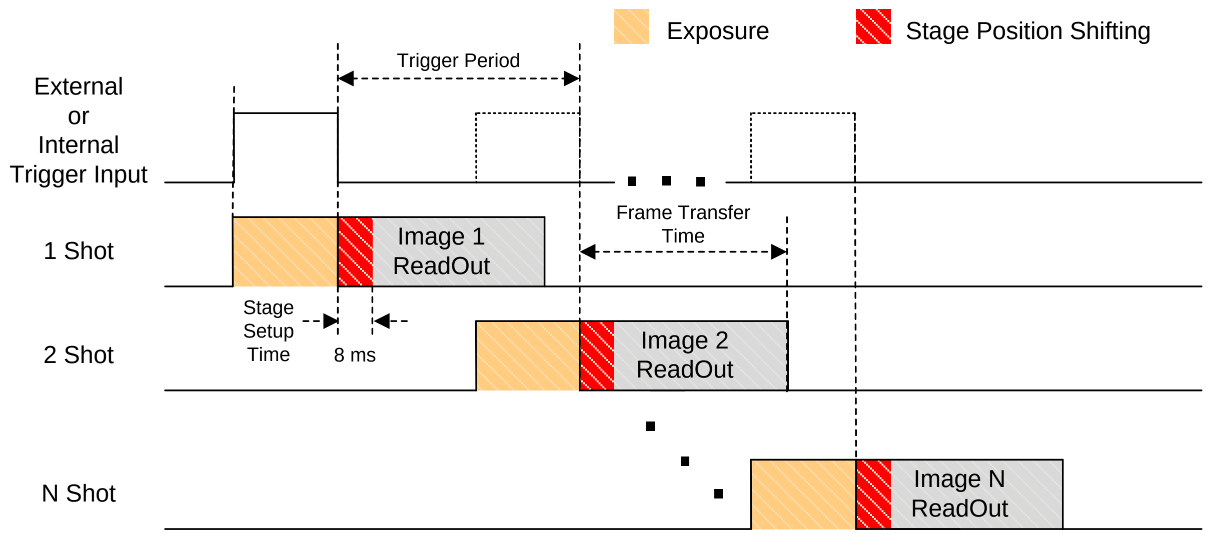


Figure 8.25 Sequence Mode Timing Diagram

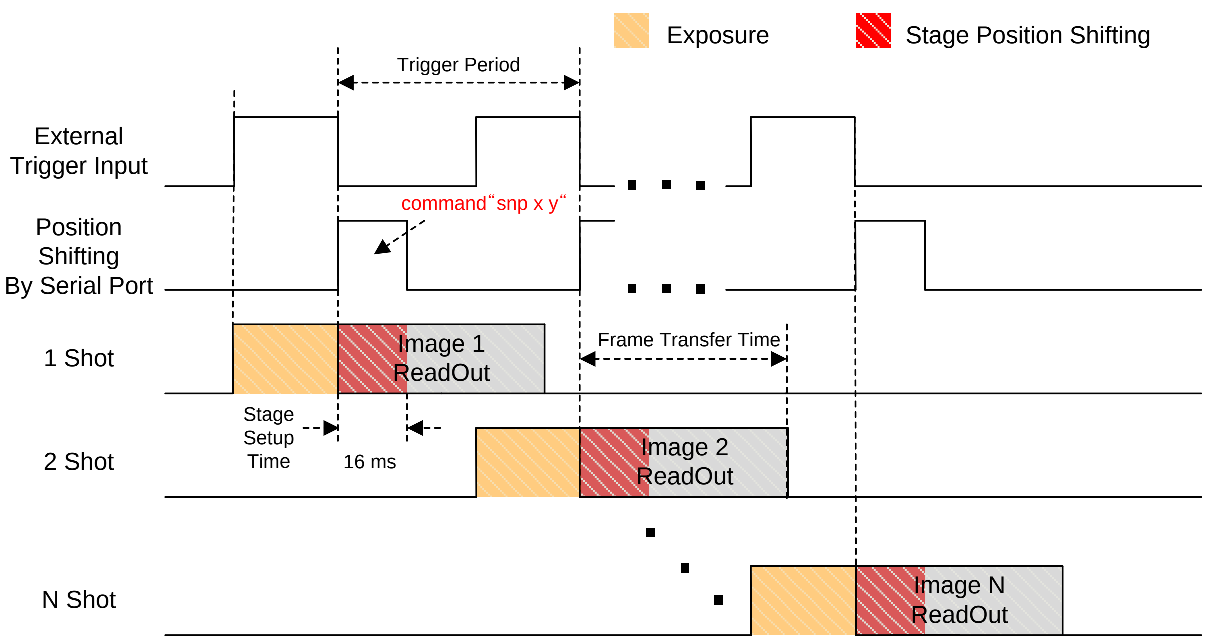


Figure 8.26 Manual Mode Timing Diagram

8.12.2.3 Multi Shot Mode

When Multi Shot Mode is activated, the sequence operation that is followed by the first trigger input will be performed automatically by internal trigger. Internal trigger is generated by calculating the optimized timing reflecting trigger delay and stage setup time. Trigger input from external ports will be ignored until completing the readout of the last image.

```
Multi Shot Enable : 1 trigger N snap
Sequence is performed in sequence with one trigger input.
```

```
Multi Shot Disable : 1 trigger 1 snap
Exposure synchronizes with trigger input and N times trigger input will be
needed to acquire N images.
```

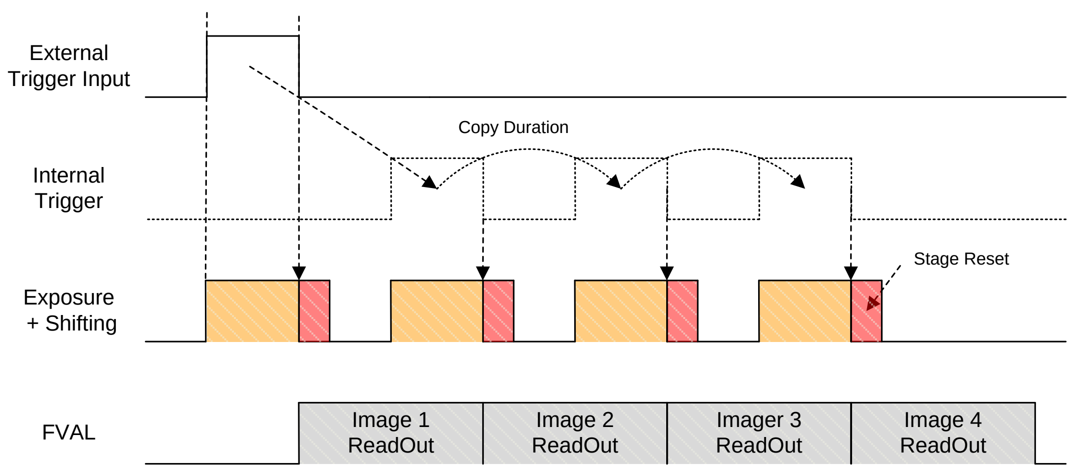


Figure 8.27 Timing Diagram when Multi Shot is enabled on Sequence 4 Shot mode

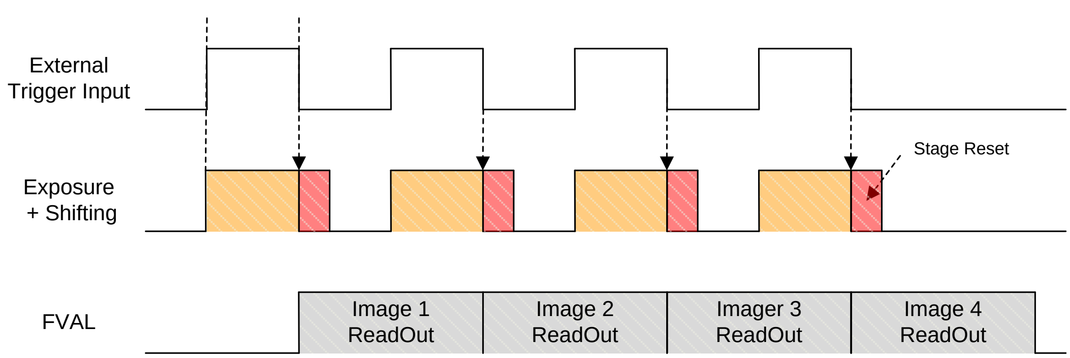


Figure 8.28 Timing Diagram when Multi Shot is disabled on Sequence 4 Shot Mode

8.12.2.4 Stage Reset

The stage can be reset by using Reset command (“rnp”) or Camera Link Camera Control Port (CC2) input. Stage reset performs following two functions depending on the status of the stage.

- Sequence Mode reset
  - When stage reset command is entered while running the sequence, the camera stops and resets the sequence and then returns to waiting status for trigger input.
- Stage Position Sensor Calibration
  - Zero points can be changed according to temperature changes since the displacement sensor of the stage is sensitive to temperature. This function adjusts zero point of displacement sensor so that the sensor can be maintained within the operating range.

CAUTION	Zero point drift (the displacement sensor strays from the stage’s operating range) may occur according to a physical change on mechanical parts of the camera or temperature change on installed environment. In this case, executing a Stage Reset command will compensate zero point drift to operate the stage normally.

8.12.2.5 Sequence Auto-Reset

This function will be available only when Sequence mode is activated. Sequence Auto-Reset performs Stage Reset (zero point adjustment) whenever one cycle of sequence is completed.

8.12.2.6 Stage Check

The return values of reset command (“rnp”) or move stage command (“snp”) indicate whether a stage normally operates or not. If a stage normally operates, it returns “OK”, “Error” otherwise. If Multishot is enabled, it is possible to check the stage status without using “rnp” command.

When the stage does not normally operate, the camera stops the current sequence and then checks its status via the number of frame. For example, if you set Sequence Mode to 4 shot, the camera acquire and transfer 4 images normally. However, the camera could unexpectedly stop the sequence so that 4 images cannot be transferred in abnormal operation status. At this time, you can verify the number of frame to check the stage status. You can perform more detailed test on the stage by clicking the **Stage Check** button on the Stage tab of Configurator. Then you can send test results to local dealer or manufacturer to diagnose the camera stage.

CAUTION	An impact of 10G or more would distort the operation range of stage or alignment of the sensor and cause permanent damage to the stage since it is mechanically sensitive to shocks. Please handle the camera with care.

8.12.2.7 Image Arrangement

To acquire the resulting image, the user needs to combine shifted images into one result image on the PC side with software processing. Sample source or demo program that is helpful to combine images can be provided from the local dealer or manufacturer.

8.13 Data Format

Data can be processed in the unit of 12 bit internally, but can be selectively output in the unit of 8, 10 or 12bit at output. When it is output in 8bit and 10bit unit, lower 4 bit and 2 bit are cut out from overall 12bits.

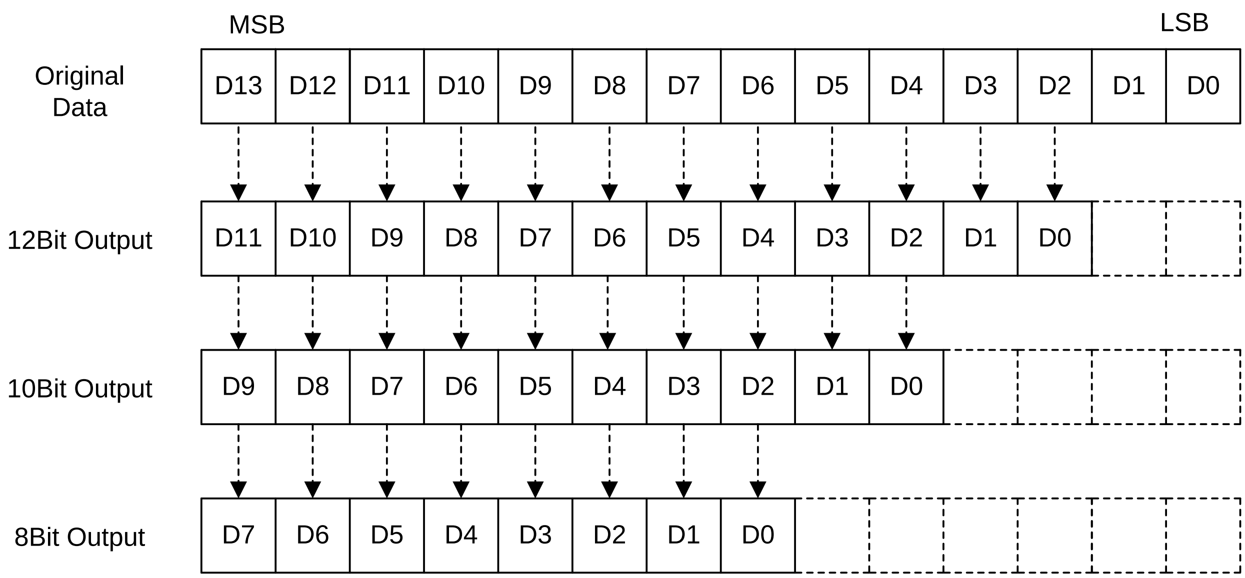


Figure 8.29 Data Format

8.14 Test Image

To check normal operation of camera, it can be set to output test image created inside, instead of image data from CCD. There are 3 types of test image; image with different value in horizontal direction (Test Image 1), image with different value in diagonal direction (Test Image 2), and moving image with different value in diagonal direction (Test Image 3). Test image can be applied in all operation modes of camera and is set using “sti” command.

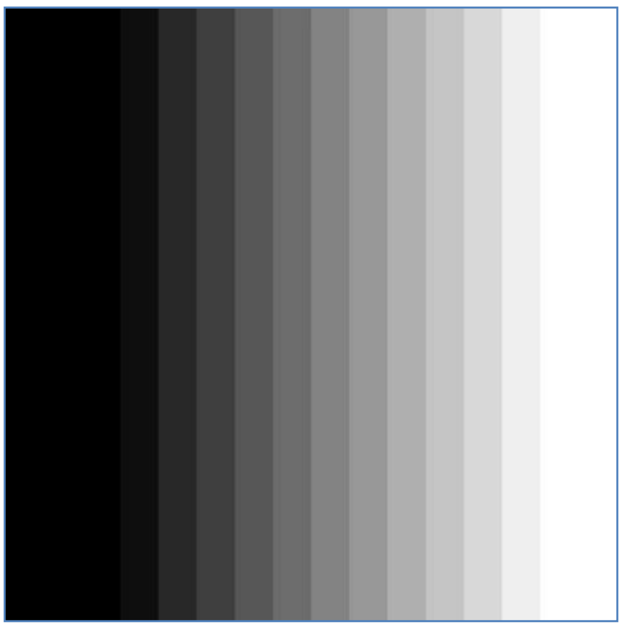


Figure 8.30 Test Image 1

Figure 8.31 Test Image 2

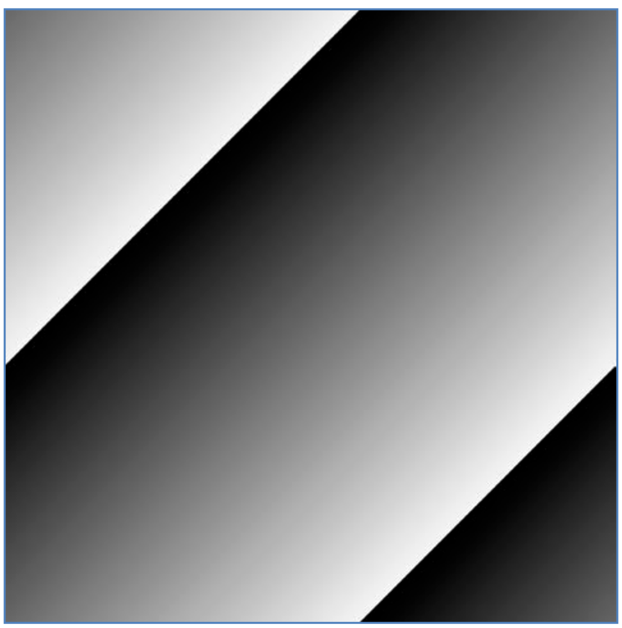


Figure 8.32 Test Image 3

8.15 Horizontal Flip (Only available on VN-11MC and VN-16MC)

Function to flip the image right and left based on the central axis of image. This function can be applied to all operation modes and “shf” command is used to set whether to use this function or not.

Figure 8.33 Original Image

Figure 8.34 Horizontally Flipped Image

8.16 Image Invert (Positive/Negative)

Function to invert the level value of output image. Level value inverted differs depending on output data format even if input value is same. This function can be applied in all operation modes of camera and "sii" command is used to set whether to use this function or not.

Data Format	Original Value	Inverted Level Value
8	0	255
10	0	1023
12	0	4095

Table 8.4 Inverted level value by Data Format

Figure 8.35 Original image (Positive)

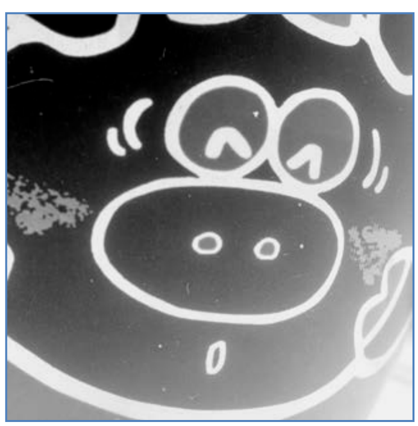


Figure 8.36 Inverted image (Negative)

8.17 Strobe

Strobe signal is used to synchronize the external light source with camera or to measure the exposure time applied to current camera. Pulse width of Strobe signal is from the generating point of Shutter signal to the starting point of Readout, which coincides with exposure time of camera.

8.17.1 Strobe Offset

Strobe Offset value indicates when Strobe signal is to be sent after Shutter signal. Value can be set in the unit of 1 ㎲ using “sso” command. Only pulse location moves without change in pulse width of Strobe signal.

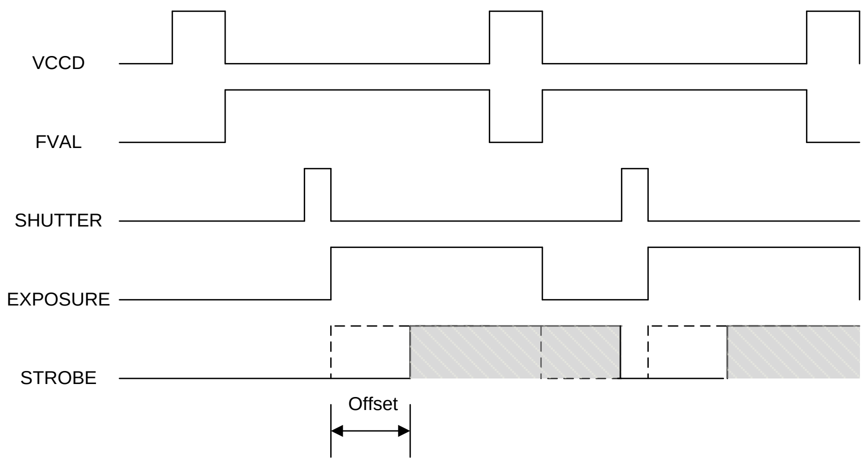


Figure 8.37 Strobe signal in Free-Run

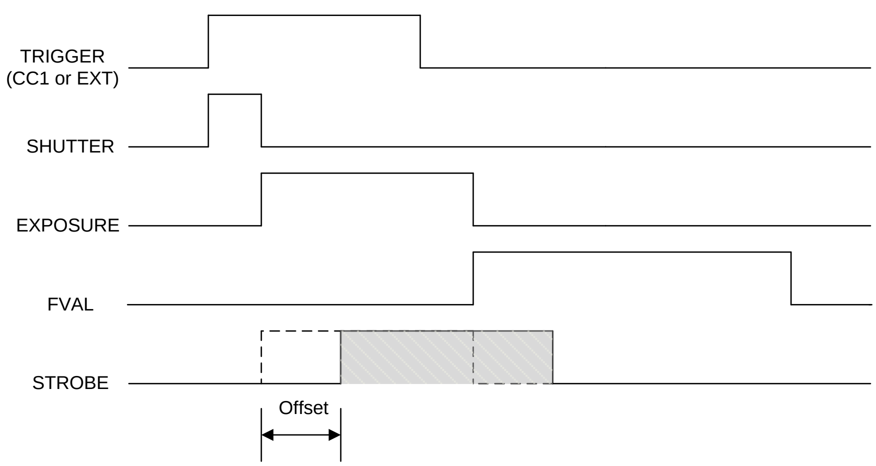


Figure 8.38 Strobe signal in Trigger mode

8.17.2 Strobe Polarity

Polarity can be set for Strobe signal output. “ssp” command is used to set the polarity of Strobe signal.

8.18 Field Upgrade

The Camera provides the function to upgrade Firmware and FGPA logic through Camera Link interface rather than disassemble the camera in the field. See Appendix C for details on how to upgrade.

9 Camera Configuration

9.1 Setup command

All setup in camera is carried out RS-644 serial interface of camera link. With the following communication setting, it can be controlled using terminal or direct control at user application.

- Baud Rate: 115200 bps
- Data Bit: 8 bit
- Parity Bit: No Parity
- Stop bit: 1 stop bit
- Flow control: None

All types of camera setting commands except Firmware Download, requiring massive data transmission are delivered in ASCII command type. All camera setup commands start from user application and the camera returns the response ("OK", "Error" or information) for command. The camera informs the completion of command execution through response with write command, while the camera returns the error response or information with read command.

```
Command format:
<command> <parameter1> <parameter2> <\r>
0~2 parameters follow the command.
Response:
- If execution of write command is successfully completed
 OK <\r> <\n>
```

ex) Write command

```
In response to a "set 100" command the camera will return (in hex value)
Command     : 73 65 74 20 31 30 30 0D
              set 100<\r>
Response    : 73 65 74 20 31 30 30 0D 0A 4F 4B 0D 0A 3E
              Set 100<\r><\n>            OK<\r><\n>  >
              Echo                       result      prompt
```

```
If execution of read command is successfully completed
<parameter1> <\r> <\n>
```

ex) Read command

```
In response to a "get" command the camera will return (in hex value)
Command     : 67 65 74 0D
               get <\r>
Response    : 67 65 74 0D 0A 31 30 30 0D 0A 3E
               get<\r><\n>    100<\r><\n>     >
               echo           response        prompt
```

```
If execution of command is not completed
Error : <Error Code> <\r> <\n>
```

```
Prompt:
After sending response, Camera sends prompt always. '>'is used as prompt.
Types of Error Code
0x80000481 : values of parameter not valid
0x80000482 : number of parameter is not matched
0x80000484 : command that does not exist
0x80000486 : no execution right
```

9.2 Actual Time Applied for Commands

When you execute a command, the actual or real time applied for the command varies depending on the type of the command and operating status of the camera.

All commands except Set Exposure Time ('set') command are applied to change the settings as illustrated below, on the rising edge of a VCCD signal before starting readout process.

When you execute a 'set' command, the exposure time setting will be changed at the starting of the exposure.

In the Trigger mode, you must execute commands before applying trigger signals in order to synchronize image outputs with the commands.

In the Free-Run mode, even if you execute a command, you may acquire up to two images without applying the command. This is true because it is hard to verify the current operating status of the camera in the Free-Run mode.

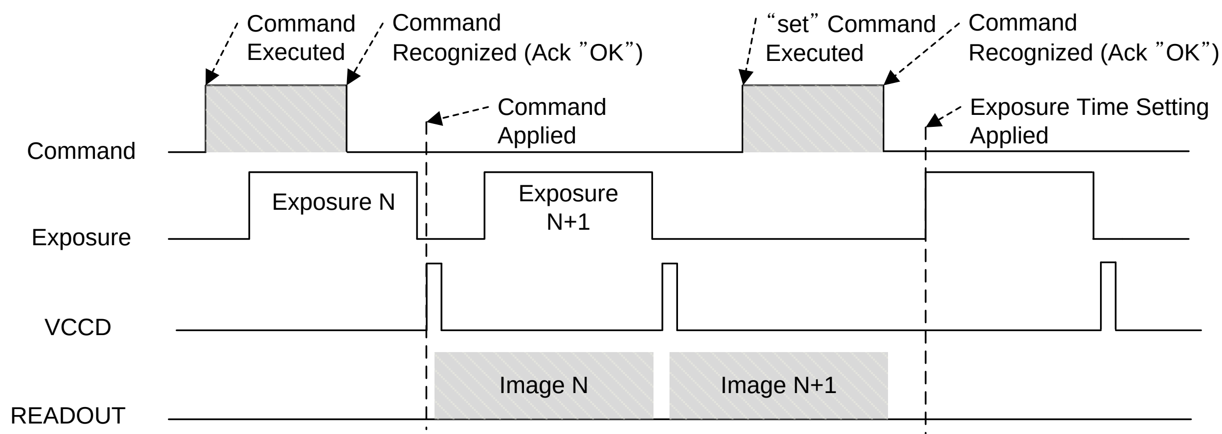


Figure 9.1 Actual Time Applied for Commands

9.3 Parameter Storage Space

The camera has 3 non-volatile storage space used for parameter storage and 1 volatile work space that is applied to actual camera operation. 3 storage space is divided into Factory Space that contain basic value at the factory, and 2 user space(User Space 1, User Space 2) that can save parameter value temporarily set by the user. User space can be read and written, but Factory space can be read only.

At camera booting, setting value in one of 3 storage spaces is copied to work space according to Config Initialization value and value of the space is used for camera setting. Since values in work space is valid only while the power is on, it should be copied to user space 1 or user space 2 using “sct” command.

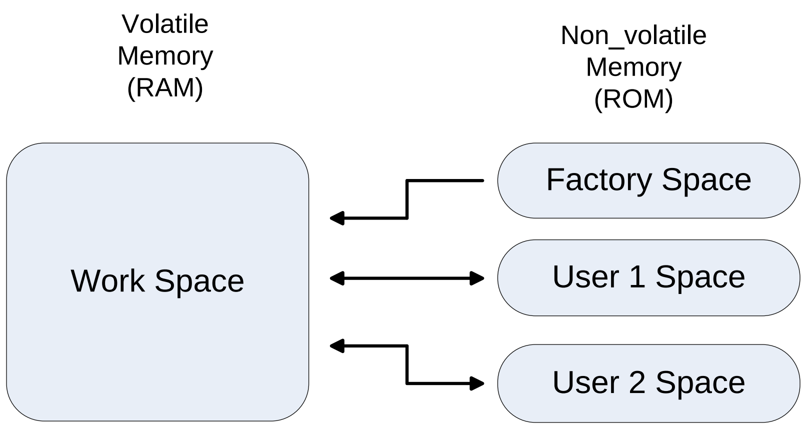


Figure 9.2 Parameter Area

9.4 Command List

Command	Syntax	Value Returned	Description
Help	h	String	Displays a list of all commands
Set Read-Out Mode Get Read-Out Mode	srm 0|1|2 grm	OK 0|1|2	0 : Normal Mode 1 : AOI(Area Of Interest) Mode (AOI area is set using “sha” and “sva” commands) 2 : Binning(2 or 4) Mode (Binning Factor is set using “sbf” command)
Set Horizontal Area Get Horizontal Area	sha n1 n2 gha	OK n1 n2	n1: Starting point of horizontal direction n2 : End point of horizontal direction
Set Vertical Area Get Vertical Area	sva n1 n2 gva	OK n1 n2	n1 : Starting point of vertical direction n2 : End point of vertical direction
Set Binning Factor Get Binning Factor	sbf 2|4 gti	OK 2|4	2 : 2 by 2 binning 4 : 4 by 4 binning
Set Test Image Get Test Image	sti 0|1|2|3 gti	OK 0|1|2|3	0 : Off 1/2 : Fixed Pattern Image 3 : Moving Pattern Image
Set Data Bit Get Data Bit	sdb 8|10|12 gdb	OK 8|10|12	8 : 8 Bit Output 10 : 10 Bit Output 12 : 12 Bit Output
Set LUT Select Get LUT Select	sls 0|1|2 gls	OK 0|1|2	0 : Off 1 : LUT1 2 : LUT2
Set Asynchronous Reset Get Asynchronous Reset	sar 0|1 gar	OK 0|1	0 : Inactivate Asynchronous Reset 1 : Activate Asynchronous Reset
Set Channel Mode Get Channel Mode	scm 1|2|4 gcm	OK 1|2|4	1 : 1 Channel Mode 2 : 2 Channel Mode 4 : 4 Channel Mode
Set Flat-Field Correction Get Flat-Field Correction	sfc 0|1 gfc	OK 0|1	0 : Off 1 : Active of Flat-Field Correction
Set Defect Correction Get Defect Correction	sdc 0|1 gdc	OK 0|1	0 : Off 1 : Active of Defect Correction

Table 9.1 Command List #1

Command	Syntax	Value Returned	Description
Set Image Invert Get Image Invert	sii 0|1 gii	OK 0|1	0 : Off 1 : Active of Image Invert
Set Horizontal Flip Get Horizontal Flip	shf 0|1 ghf	OK 0|1	0 : Off 1 : Active of Defect Correction
Set Trigger Mode Get Trigger Mode	stm 0|1|2|3|4 gtm	OK 0|1|2|3|4	0 : Free-Run Mode 1 : Standard Mode 2 : Fast Mode 3 : Double Mode 4 : Overlap Mode
Set Exposure Source Get Exposure Source	ses 0|1 ges	OK 1|2	0 : Program Exposure(by camera) 1 : Pulse Width (by trigger input signal)
Set Trigger Source Get Trigger Source	sts 1|2 gts	OK 1|2	1 : CC1 Port Input (Camera Link) 2 : External Input (External control port)
Set Trigger Polarity Get Trigger Polarity	stp 0|1 gtp	OK 0|1	0 : Active Low 1 : Active High
Set Exposure Time Get Exposure Time	set n get	OK n	n : Exposure Time in us (Setting range : 10 ~ 7,000,000 ㎲)
Set Strobe Offset Get Strobe Offset	sso n gso	OK n	n : Strobe Offset Time in us (Setting range : 0 ~ 10,000 ㎲)
Set Strobe Polarity Get Strobe Polarity	ssp 0|1 gsp	OK 0|1	0 : Active Low 1 : Active High
Set Analog Gain Get Analog Gain	sag n gag	OK n	n :Analog Gain Parameter (Setting Range : 0 ~ 899)
Set Analog Offset Get Analog Offset	sao n gao	OK N	n :Analog Gain Parameter (Setting Range : 0 ~ 255)
Set Gain Offset Get Gain Offset	sgo 2|3|4 n ggo 2|3|4	OK n	2 : AFE Channel of Right Top Image 3 : AFE Channel of Left Bottom Image 4 : AFE Channel of Right Bottom Image n : Analog Gain offset Parameter (Setting Range : -20 ~ +20)
Auto Gain Offset	ago	OK	Auto-Generation Gain Offset

Table 9.2 Command List #2

Command	Syntax	Value Returned	Description
Generate Flat Field Data	gfd	OK	Operate Flat Field Generator
Save Flat Field Data	sfd	OK	Save Flat Field Data
Load Flat Field Data	lfd	OK	Load Flat Field Data
Set Flat Field Iteration Get Flat Field Iteration	sfi n gfi	OK n	n : (2 ^ n) image acquisitions (Setting Range : 0 ~ 4)
Set Flat Field Offset Get Flat Field Offset	sfo n gfo	OK n	n : Flat Field Target Level (Setting Range : 0 ~ 4095)
Set Dark Signal Non-uniformity Get Dark Signal Non-uniformity	sdsnu 0|1 gdsnu	OK 0|1	0: Disable DSNU 1: Enable DSNU

Table 9.3 Command List #3

Command	Syntax	Value Returned	Description
Load Config From	lcf 0|1|2	OK	0 : Load from Factory Setting 1 : Load from User 1 Setting 2 : Load from User 2 Setting
Save Config To	sct 1|2	OK	0 : Save to User 0 Setting (inactive) 1 : Save to User 1 Setting 2 : Save to User 2 Setting
Set Config Initialization Get Config Initialization	sci 0|1|2 gci	OK 0|1|2	0 : Load from Factory Setting when initializing 1 : Load from User 1 Setting when initializing 2 : Load from User 2 Setting when initializing
Get MCU Version	gmv	String	Displays MCU Version
Get Model Number	gmn	String	Displays Camera Model Number
Get FPGA Version	gfv	String	Displays FPGA Version
Get Serial Number	Gsn piece	String	Display Serial Number
Get Current Temperature	gct	String	Display Temperature Value
Set Pclk Selection Get Pclk Selection	sps 0|1 gps	OK 0|1	0 : Pixel Clock 30 MHz 1 : Pixel Clock 40 MHz

Table 9.4 Command List #4

Command	Syntax	Value Returned	Description
Set Nano-Stage Position Get Nano-Stage Position	Snp <axis> <pos> Gnp <axis>	OK <pos>	Move stage to specified position Axis : x or y Pos : position Ex) snp x 50 : move stage to 50㎚ position toward x coordinate.
Reset Nano-Stage Position	rnp		Reset stage position to (0,0) & Calibrate stage position sensor.
Set Sequence Mode Get Sequence Mode	Ssm 0|1|2|3|4|5 Gsm	OK 0|1|2|3|4|5	0 : None(Manual) 1 : 4 Shot Mono 2 : 9 Shot Mono 3 : 4 Shot Color 4 : 16 Shot Color 5 : 36 Shot Color
Set Multi Shot Enable Get Multi Shot Enable	Sme 0|1 Gsm	OK 0|1	0 : Disable 1 : Enable
Set Reset Polarity Get Reset Polarity	Srp 0|1 Grp	OK 0|1	Set Camera Link – CC2 Port (Stage Reset) Polarity 0 : Active Low 1 : Active High
Set Sequence Auto-Reset Get Sequence Auto-Reset	Ssr 0|1 Gsr	OK 0|1	Stage reset after stage sequence 0 : Off 1 : On

Table 9.5 Command List #5

10 Configurator GUI

Configurator, a sample application, is provided to control VN Series camera. Configurator provides easy-to-use Graphic User Interface (GUI) for the user while using the commands mentioned previous chapters.

10.1 VN Camera Scan

When you execute the program while the camera is turned on, Camera Scan window appears as shown in the figure below. At this time, the program checks serial port of computer and DLL provided by camera link to scan whether the camera is connected. If there is a camera connected, it displays model name on the screen. If the camera is not properly displayed on the screen, check the connection of cable with power of camera and press refresh button. When you double-click model name displayed on the screen, Configurator is executed and displays current setting value of camera connected.

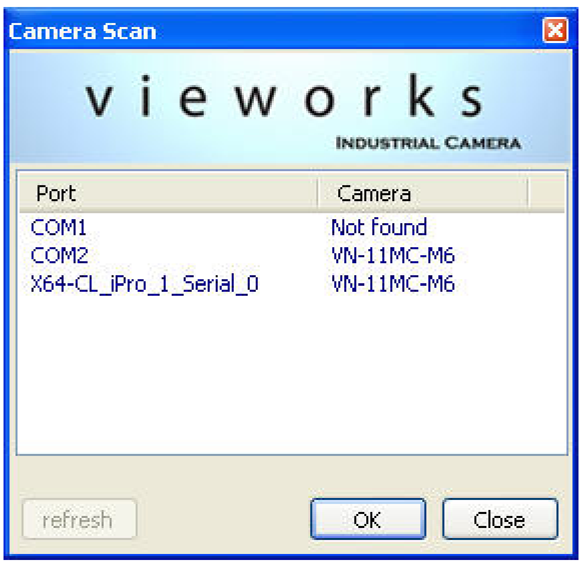


Figure 10.1 Configurator Loading Window

10.2 Menu

10.2.1 File

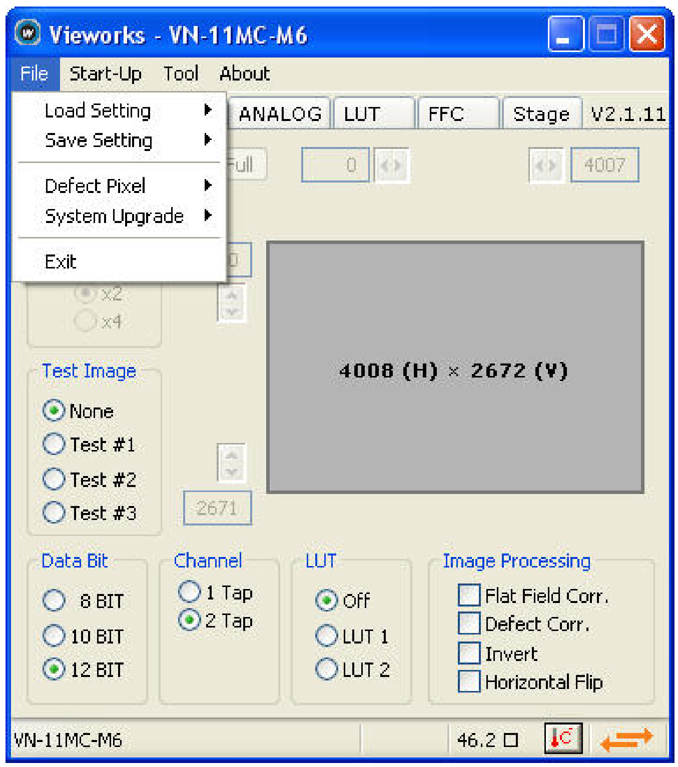


Figure 10.2 File menu

- Load Setting: Loads the camera setting values from the camera memory (i.e., specified as Factory, User1 or User2) or user computer (From File).
- Save Setting: Saves the camera setting values to the camera memory (i.e., specified as User1 or User2) or user computer (To File).
- Defect Pixel: Downloads defect information to the camera (Download to Camera) or uploads defect information saved in the camera to user computer (Upload to PC).
- System Upgrade: Upgrades MCU program or FPGA logic.
- Exit: Exits Configurator.

10.2.2 Start-Up

The user can select the camera setting values to load when the camera is turned on.

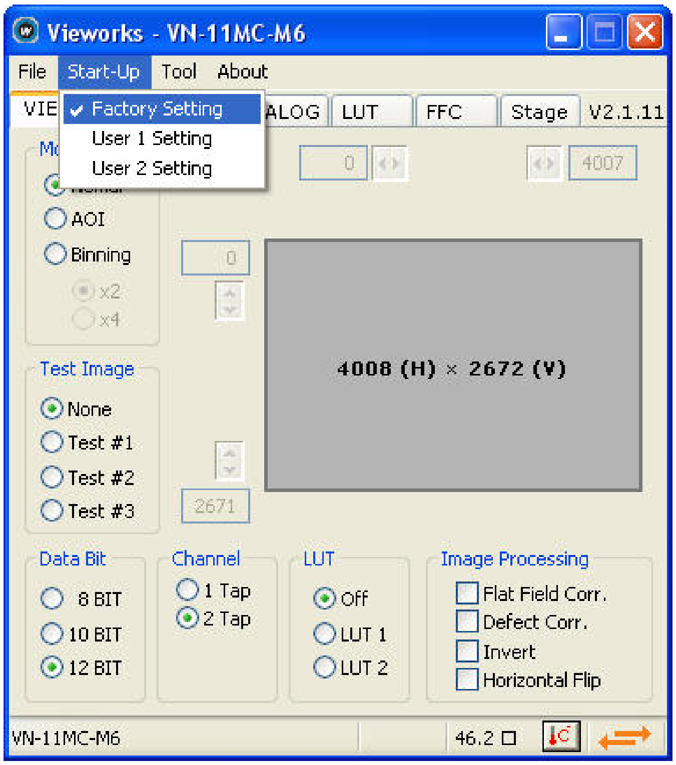


Figure 10.3 Start-Up Menu

- Factory Setting: Loads the camera setting values from Factory Space.
- User1 Setting: Loads the camera setting values from User1 Space.
- User2 Setting: Loads the camera setting values from User2 Space.

10.2.3 Tool

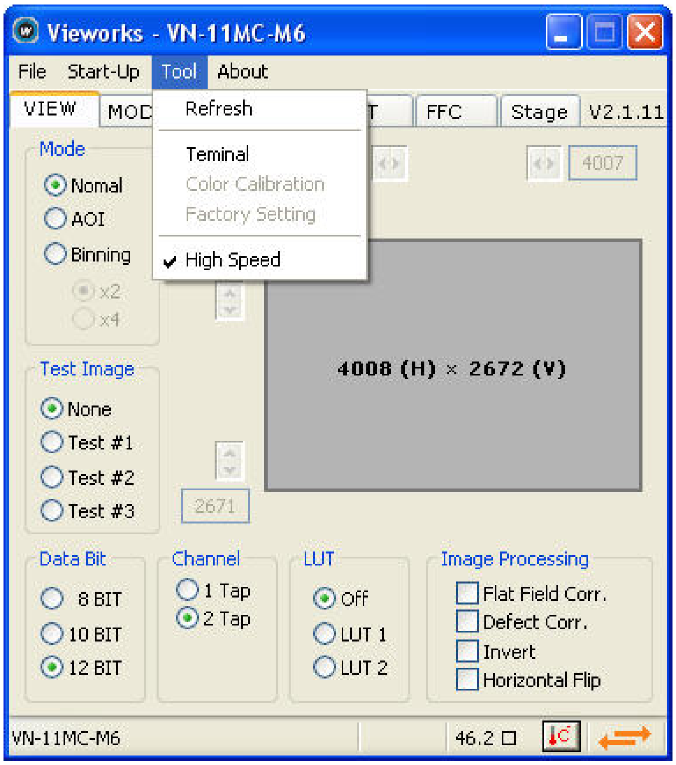


Figure 10.4 Tool Menu

- Refresh: Loads and displays the current camera setting values on Configurator.
- Terminal: Displays user commands in Terminal window under GUI. To hide Terminal window, uncheck Terminal by clicking again.
- Color Calibration: Performs Bayer sensor color calibration.
- Factory Setting: Not supported in the user side.
- High Speed: Operates the camera with 40 ㎒ pixel clock (Not supported on VN-8MC).

10.2.4 About

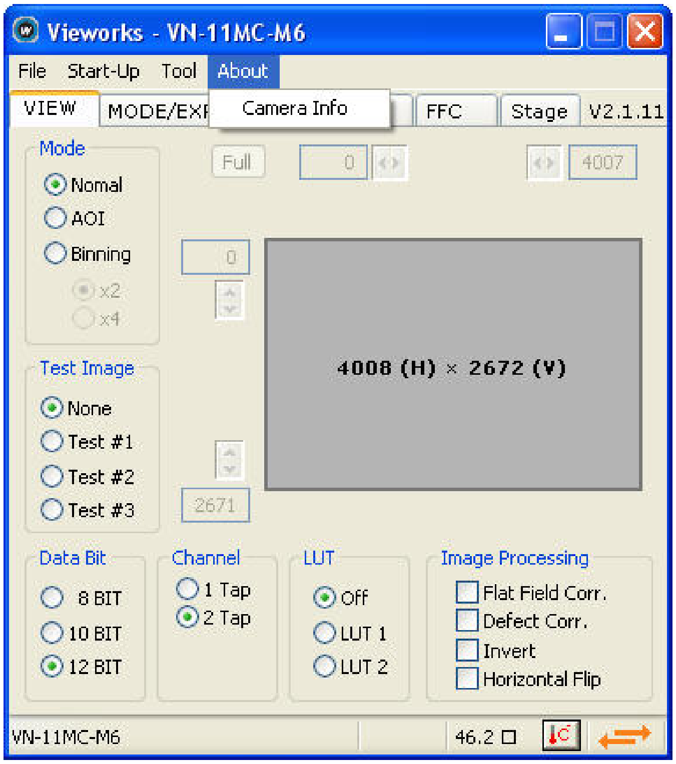


Figure 10.5 About Menu

- Camera Info: Displays camera information (product name, serial number, version, etc).

10.3 Tab

10.3.1 VIEW Tab

VIEW tab allows the user to set the camera readout mode, test image mode, data bit, channel, LUT, image processing, etc.

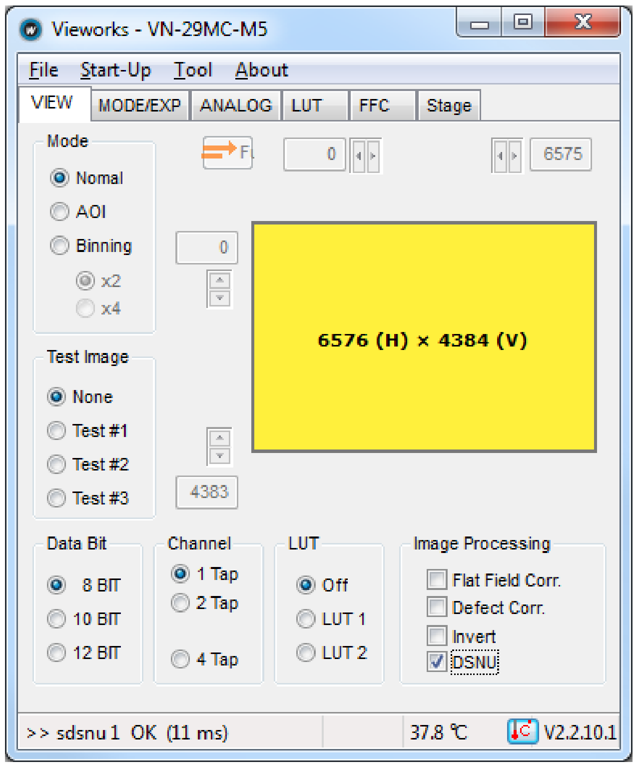


Figure 10.6 VIEW Tab

- Mode: Selects readout mode. If AOI is selected, AOI setting area is activated and AOI can be set by entering desired values. If Binning is selected, ×2, ×4 option buttons are activated.
- Test Image: Selects whether to apply test image and type of test image.
- Data Bit: Selects width of data output.
- Channel: Selects channel mode.
- LUT: Selects whether to apply LUT and type of LUT.
- Imaging Processing: Sets Flat Field Correction, Defect Correction, Image Invert, Horizontal Flip (VN-11MC/16MC Only) or DSNU (VN-8MC/29MC Only) functions On or Off.

10.3.2 MODE/EXP Tab

MODE/EXP tab allows the user to select trigger mode, exposure time and strobe. All scroll bars are controllable with the mouse wheel scroll.

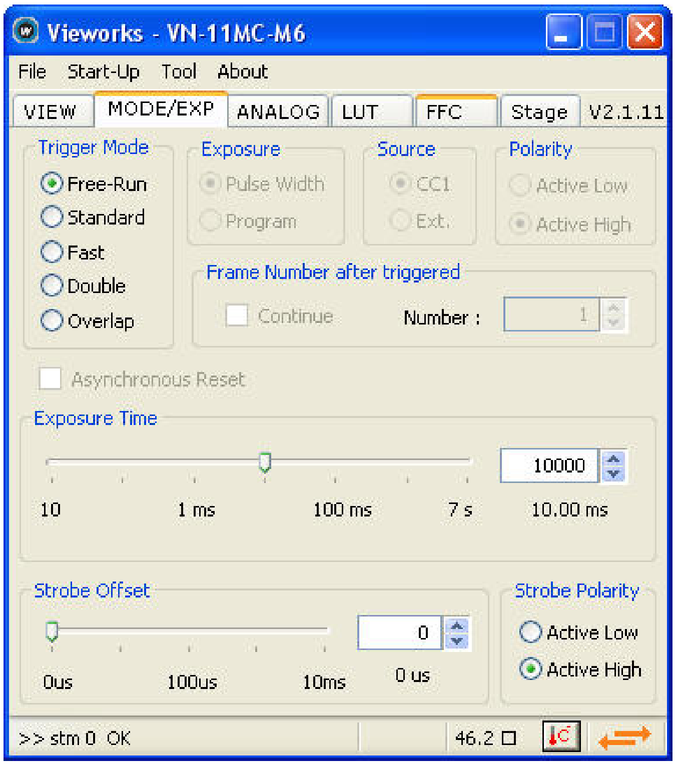


Figure 10.7 MODE/EXP Tab

- Trigger Mode: Selects trigger mode. Once a mode has been selected, related selections will be activated.
- Exposure: Selects exposure source.
- Source: Selects trigger source.
- Polarity: Selects polarity of trigger input.
- Asynchronous Reset: Sets asynchronous reset On or Off.
- Frame Number After triggered: Activated in Standard mode and sets the number of frame to receive after triggering.
- Exposure Time: Sets exposure time when trigger mode is set with Free-Run mode or when Exposure is set with Program.
- Strobe Offset: Sets strobe offset.
- Strobe Polarity: Sets the polarity of strobe output signal.

10.3.3 ANALOG Tab

ANALOG tab allows the user to set gain and offset settings of the image. All scroll bars are controllable with the mouse wheel scroll.

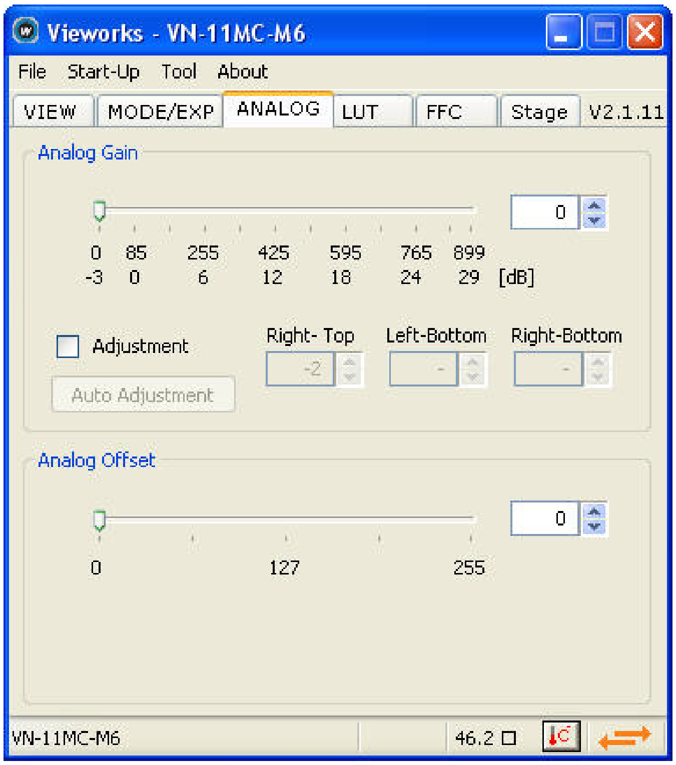


Figure 10.8 ANALOG Tab

- Analog Gain: Sets gain value of each channel. Auto Adjustment will be activated after checking Adjustment and compensates Tap differences automatically.
- Analog Offset: Sets offset values of both channels.

10.3.4 LUT Tab

LUT tab allows the user to download LUT data. See Appendix B for more details on LUT Download.

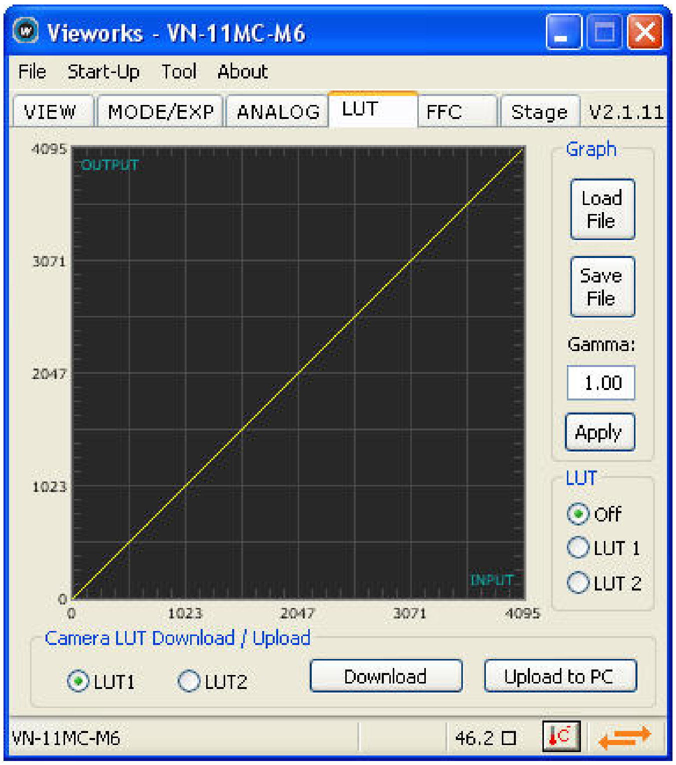


Figure 10.9 LUT Tab

- Graph: Loads LUT data from the user computer or sets Gamma value to be applied while using Gamma curve.
- Camera LUT Download / Upload: Downloads LUT data to camera from the user computer (Download) or uploads LUT data saved in the camera to the user computer (Upload to PC).

10.3.5 FFC Tab

FFC tab allows the user to set Flat Field Correction settings. All scroll bars are controllable with the mouse wheel scroll.

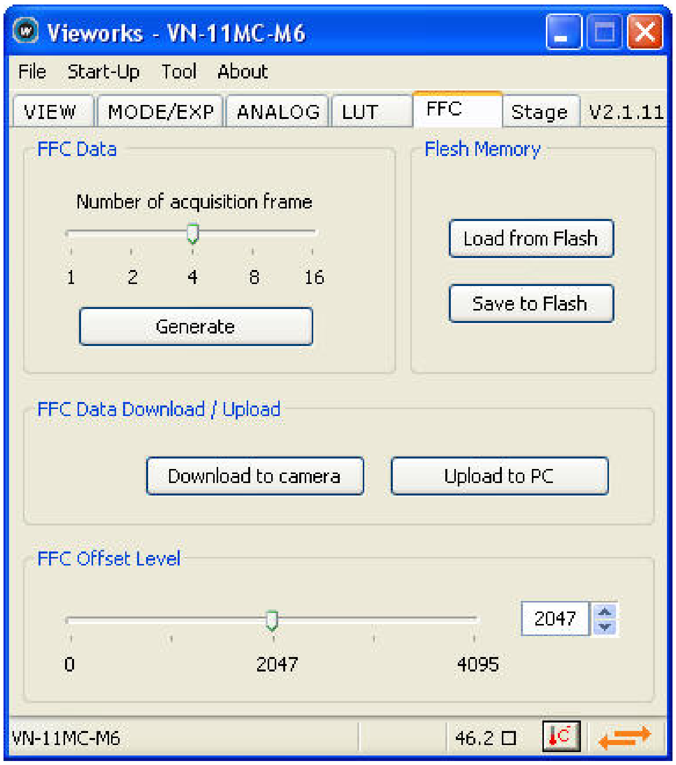


Figure 10.10 FFC Tab

- FFC data: Generates the FF data to be used for correction and sets how many images will be used for the generation.
- Flash Memory: Saves the generated FF data to Flash in order to reuse in the future or retrieves the saved FF data.
- FFC Data Download / Upload: Downloads FFC Data from the user computer (Download to camera) or uploads FFC Data to the user computer (Upload to PC).
- FFC offset Level: Sets the offset value of the image after Flat Field Correction is applied.

10.3.6 Stage Tab

Before setting the stage, the user must set MODE/EXP tab with following values.

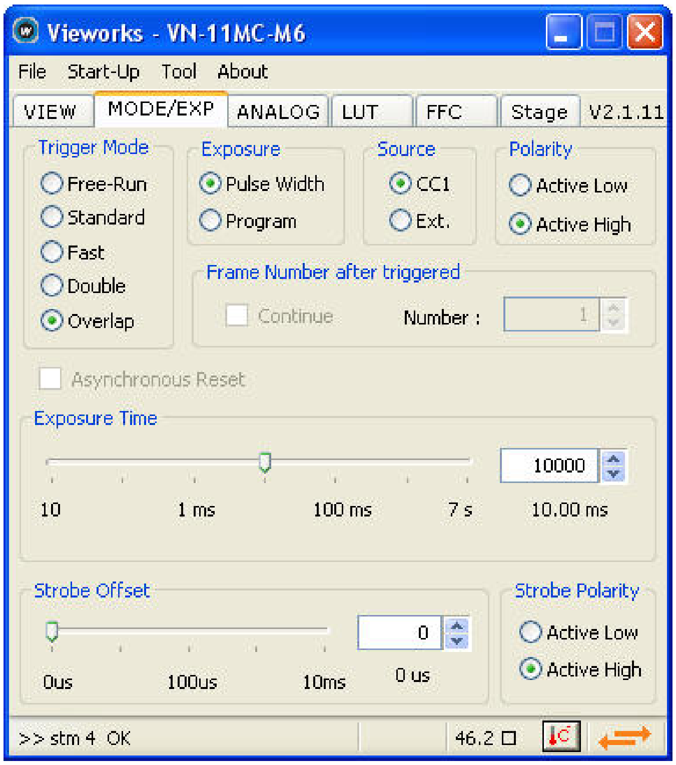


Figure 10.11 MODE/EXP settings for Nano-Stage Control

- Trigger Mode: Overlap
- Exposure: Pulse Width
- Source: CC1
- Polarity: Active High

Stage tab allows the user to set Sequence Mode and Nano-Stage.

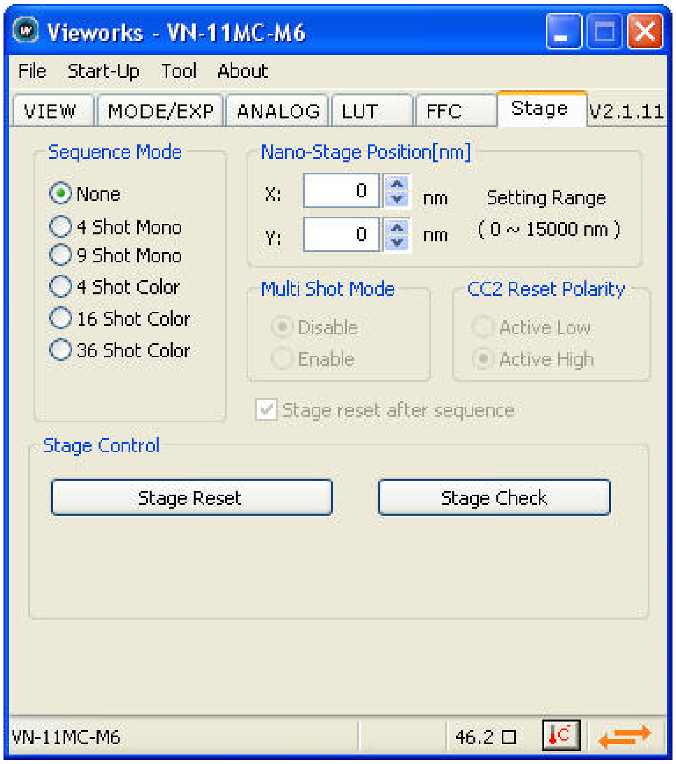


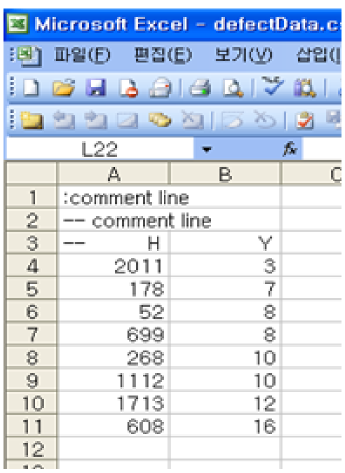
Figure 10.12 Stage Tab

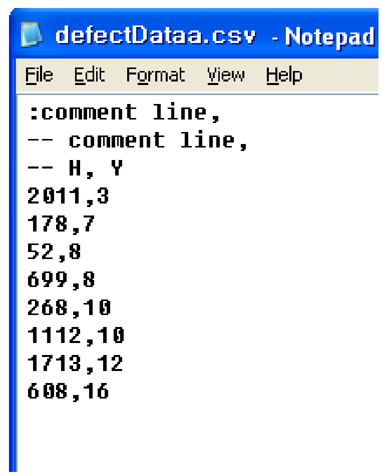
- Sequence Mode: Selects Sequence Mode. Deactivated in Free-Run Mode.
  ex) ssm 0 ← None (Manual), ssm 1 ← 4 Shot Mono
- Nano-Stage Position[㎚]
  X: Sets the stage position of X (Horizontal) direction (applicable range: 0 ~ 15,000㎚).
  Y: Sets the stage position of Y (Vertical) direction (applicable range: 0 ~ 15,000㎚).
- Multi Shot Mode: Sets Multi Shot Mode.
  Enable: 1 trigger N snap solution
  Disable: 1 trigger 1 snap solution
  ex) sme0 ← Disable, sme1 ← Enable
- CC2 Reset Polarity: Sets the reset polarity using CC2.
- Stage Reset: Initializes the stage position and adjusts zero point of displacement sensor.
- Stage Check: Performs a self test of the stage.

Appendix A Defective Pixel Map Download

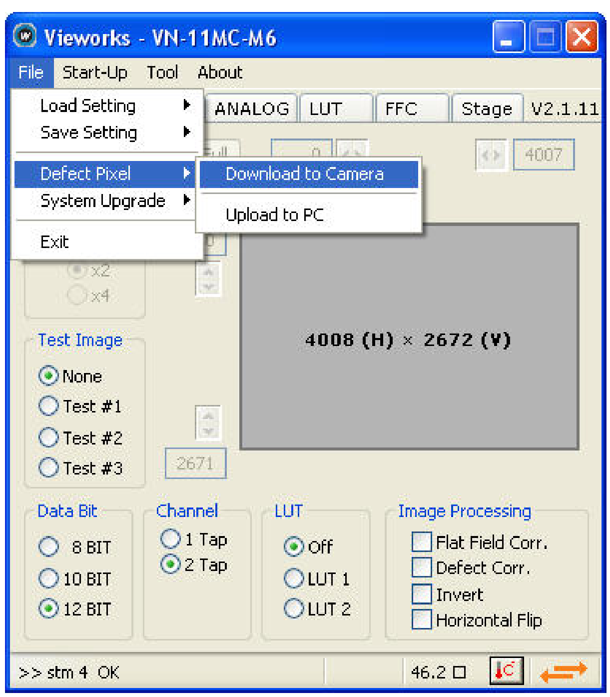
1. Create the Defective Pixel Map data in Microsoft Excel format as shown in the left picture below and save as a CSV file (*.csv). The picture in the right shows the created Excel file opened in Notepad. The following rules need to be applied when creating the file.

- Lines beginning with ':' or '—' are treated as notes.
- Each row is produced in the order of the horizontal and vertical coordinate values.
- The input sequence of pixel is irrelevant.

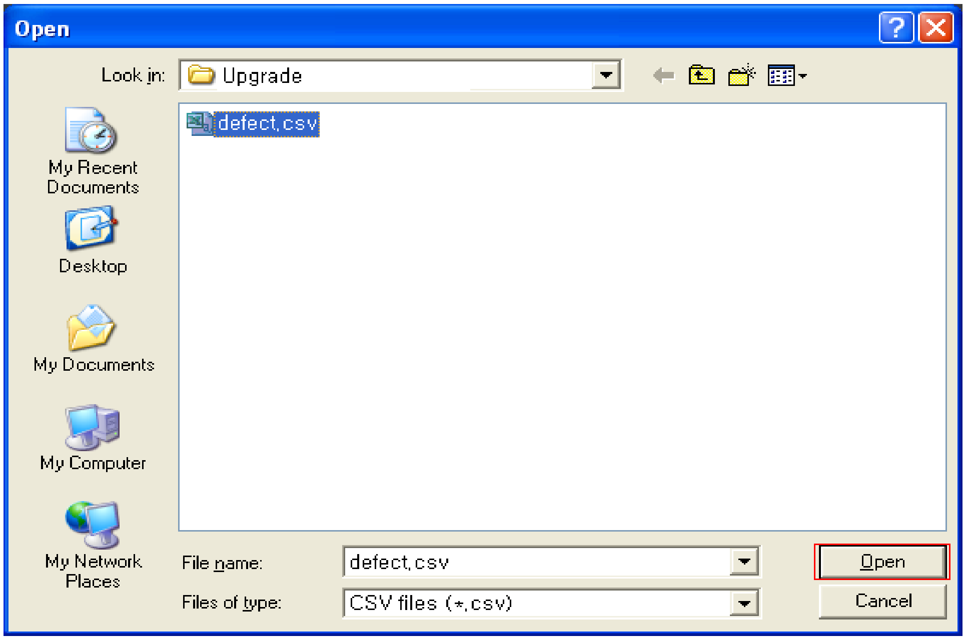




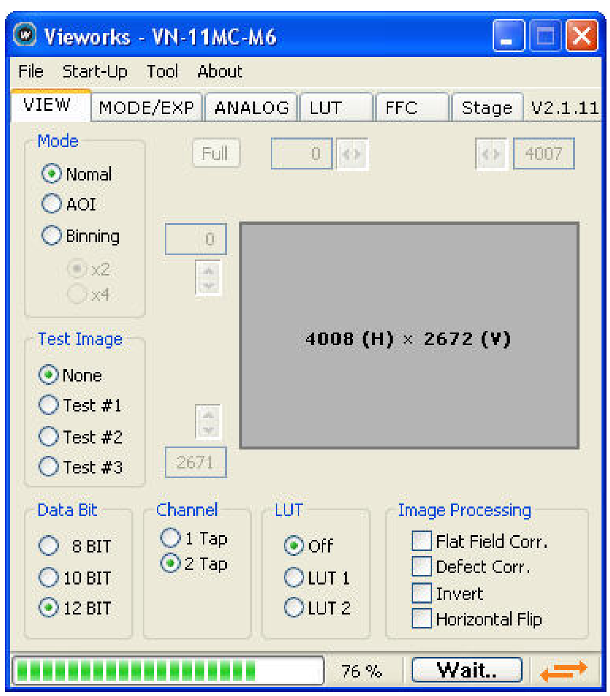
2. Select **File** > **Defect Pixel** > **Download to Camera** on Configurator.



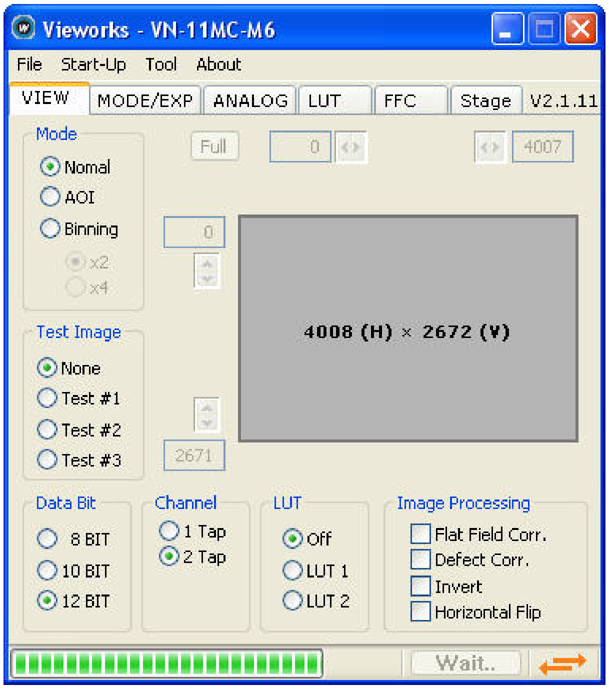
3. Search and select the created file and click **Open**.



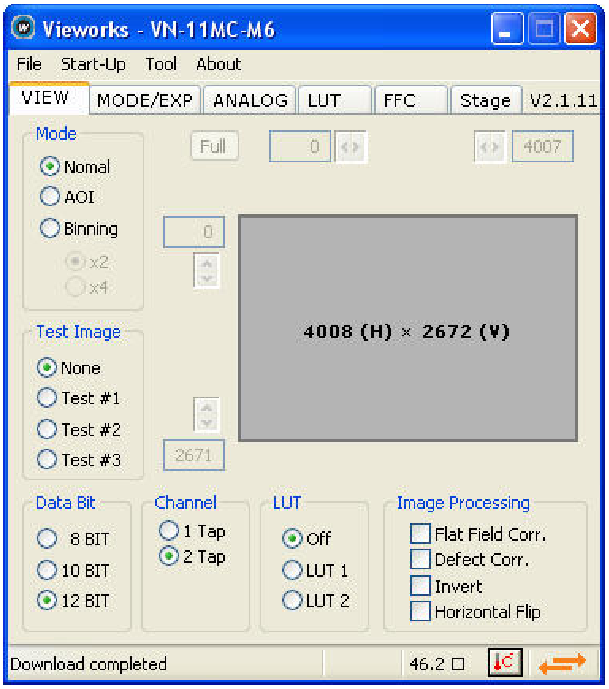
4. Configurator starts downloading defective pixel map data to the camera and downloading status is displayed at the bottom of the window.



5. Once the download has been completed, the saving process will begin. During the saving process, make sure not to disconnect the power cord.



6. Once all the processes have been completed, **Download completed** message will appear at the bottom of the window.

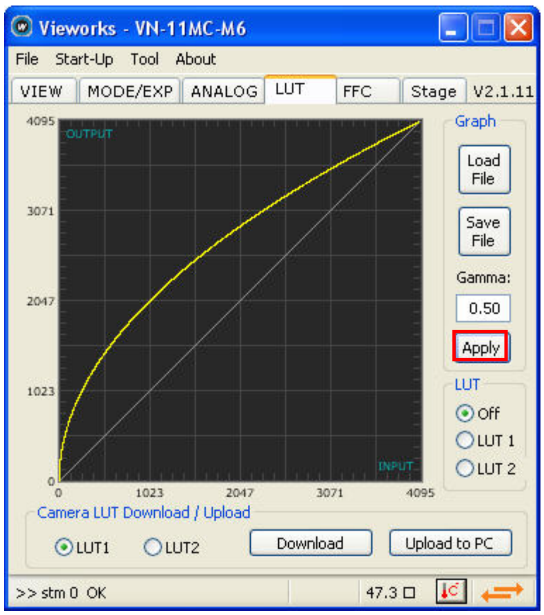


Appendix B LUT Download

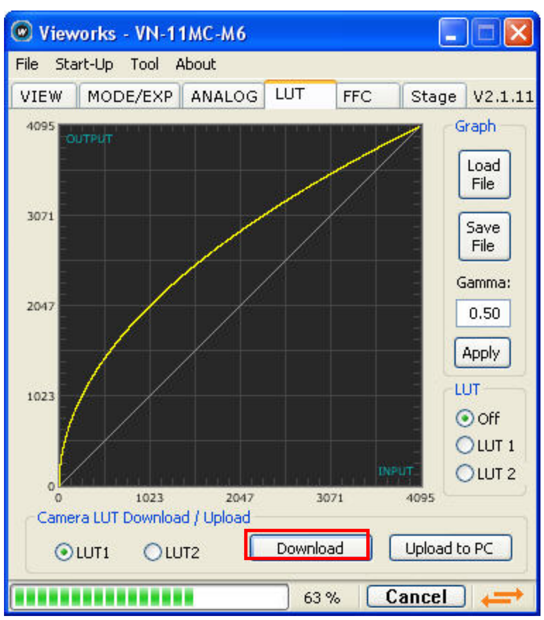
LUT data can be created in two ways; by adjusting the gamma values on the gamma graph provided in the program and then downloading the data or by opening a CSV file (*.csv) and then downloading the data.

B.1 Gamma Graph Download

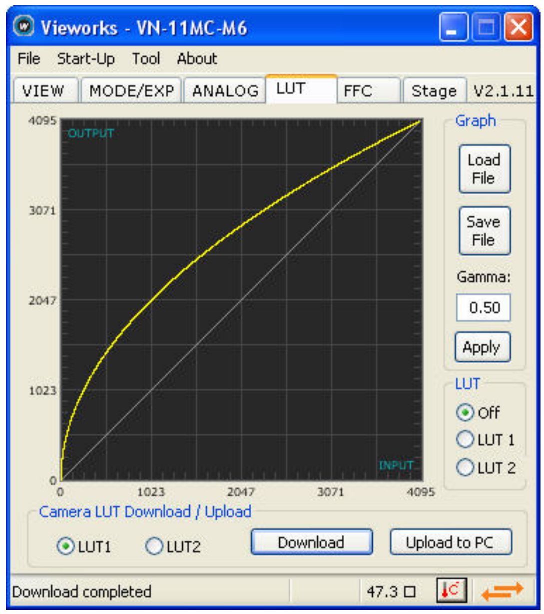
1. Set a desired gamma value on LUT tab and click **Apply**.



2. Select LUT1 or LUT2 as a location to store the data and click **Download**.



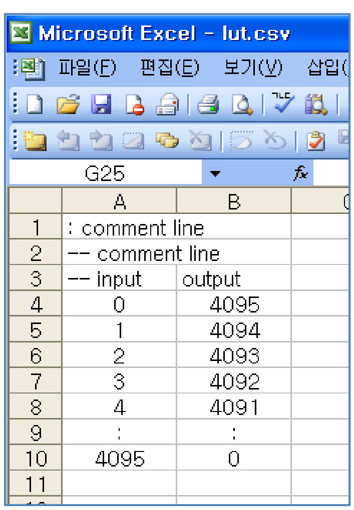
3. Once the download has been completed, **Download completed** message will appear at the bottom of the window.

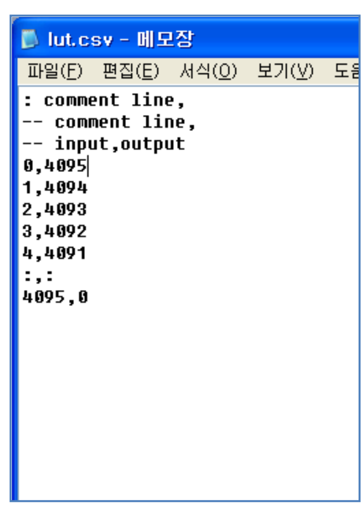


B.2 CSV File Download

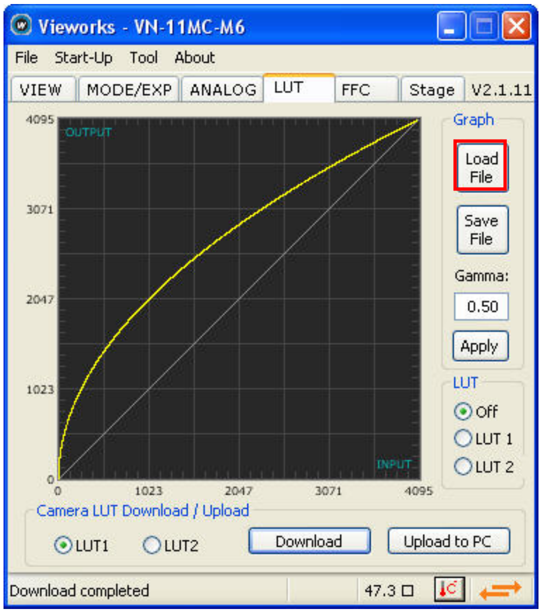
1. Create the LUT table in Microsoft Excel format as shown in the left picture below and save as a CSV file (*.csv). The picture in the right shows the created file opened in Notepad. Once the file has been created completely, change the .csv file extension to .lut. The following rules need to be applied when creating the file.

- Lines beginning with ':' or '—' are treated as notes.
- Based on the input values, make sure to record from 0 to 4095.

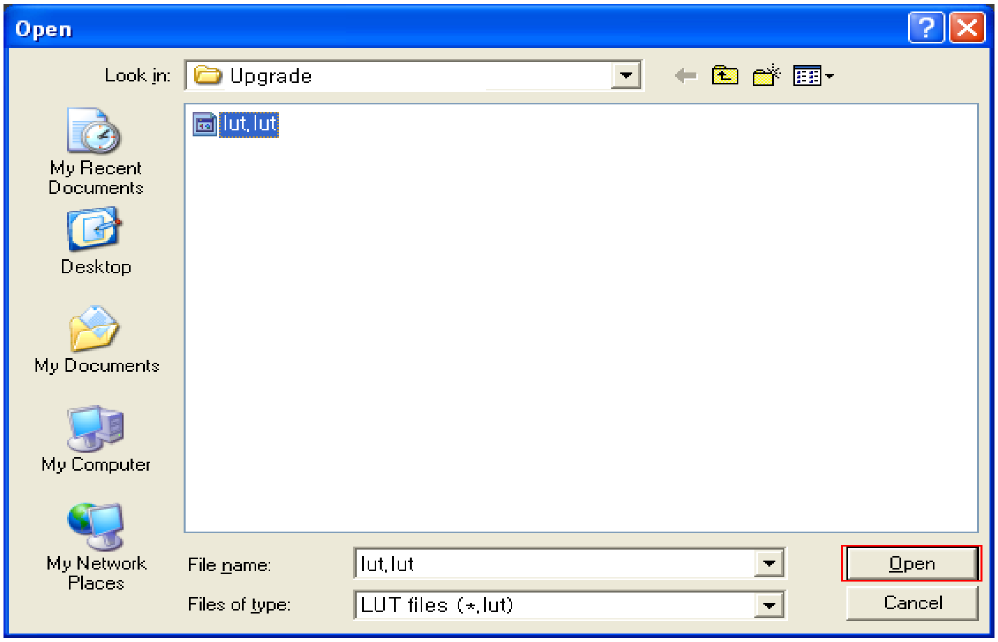




2. Click **Load File** on LUT tab.



3. Search and select the created LUT file and click **Open**.

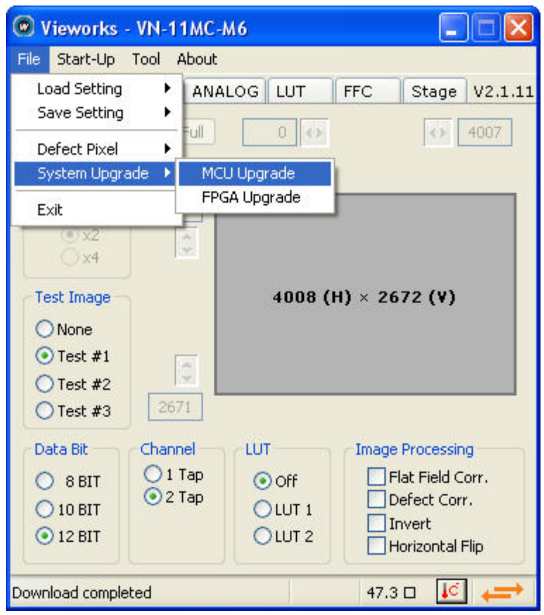


4. Select LUT1 or LUT2 as location to store the data and click **Download**. The subsequent processes are identical to those of Gamma Graph Download.

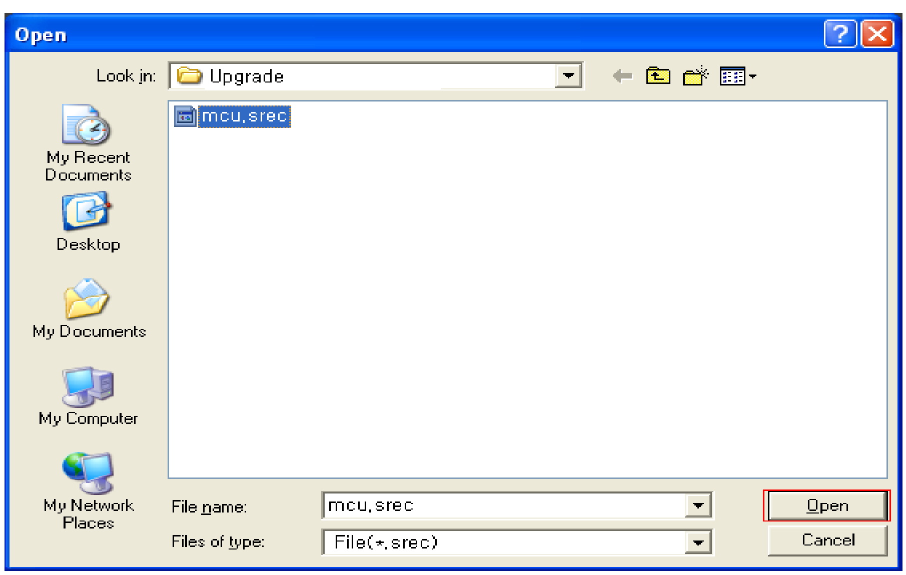
Appendix C Field Upgrade

C.1 MCU

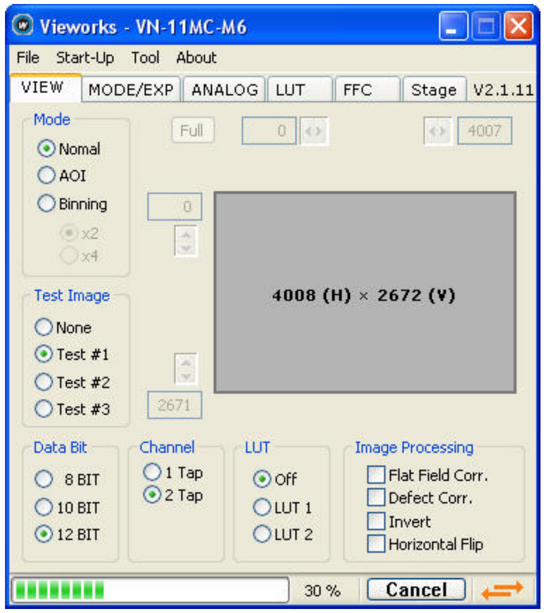
1. Select **File** > **System Upgrade** > **MCU Upgrade** on Configurator.



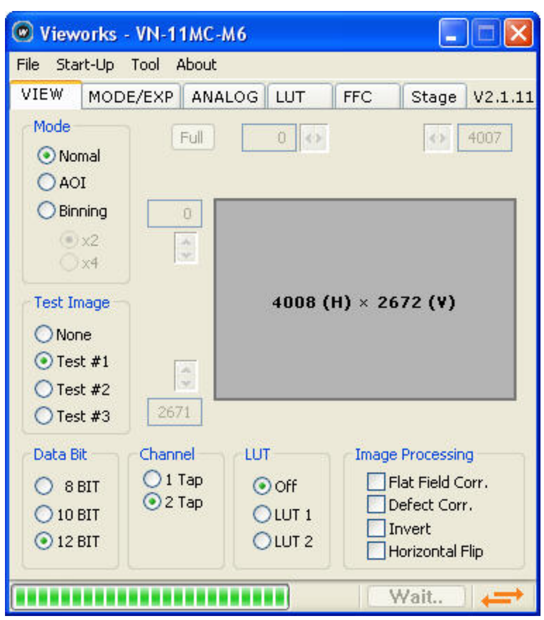
2. Search and select the provided MCU upgrade file (*.srec) then click **Open**.



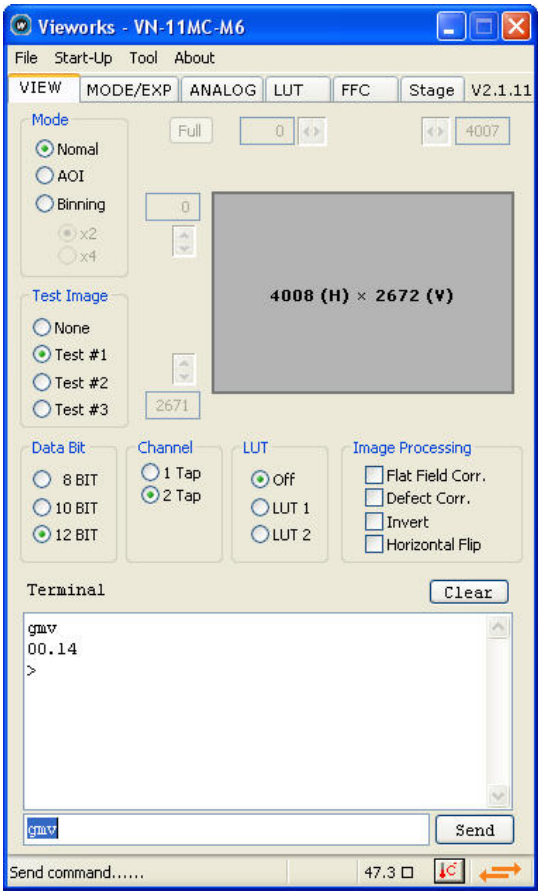
3. Configurator starts downloading MCU upgrade file to the camera and downloading status is displayed at the bottom of the window. If you want to cancel the upgrade process, click **Cancel**. This process requires several minutes to complete.

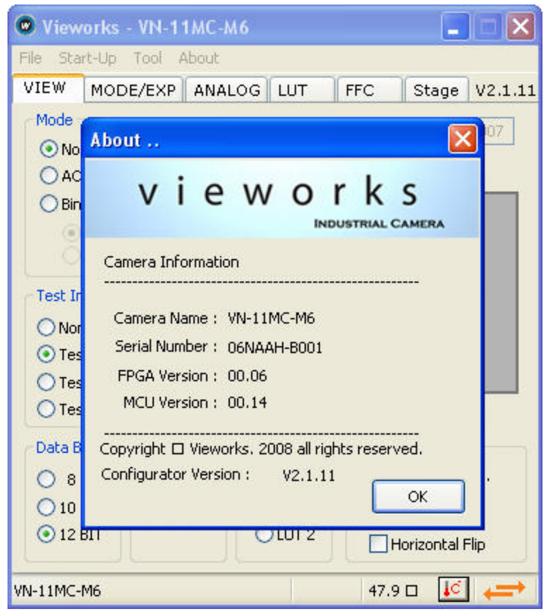


4. Once the download has been completed, the saving process will begin. During the saving process, the camera cannot be restored if a power failure occurs. Make sure that the power connection is secured.



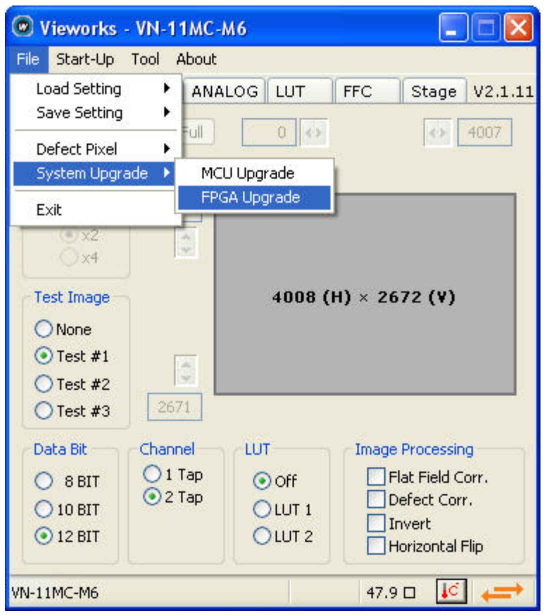
5. Once all the processes have been completed, turn the power off and turn it back on again. Select **Tool** > **Terminal** and enter the “gmv” command to confirm the version. Or, select **About** > **Camera Info** to confirm the MCU version.



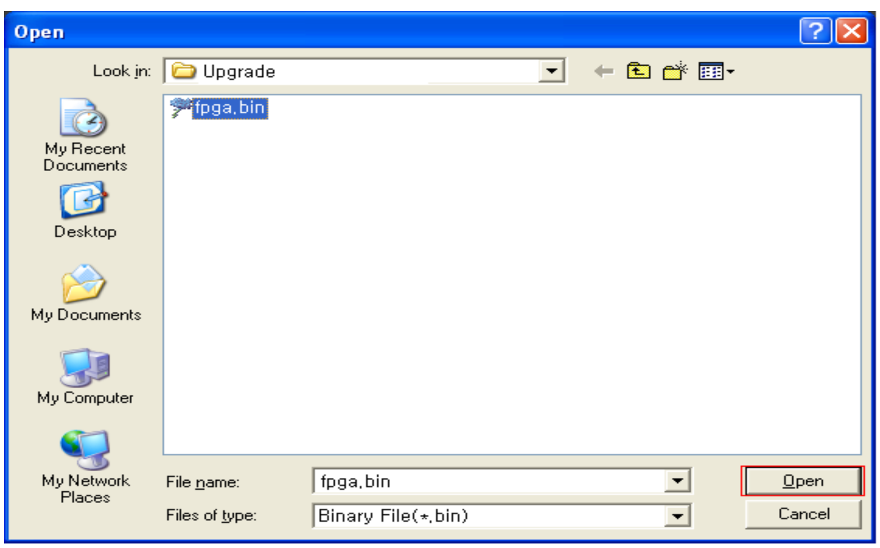


C.2 FPGA

1. Select **File** > **System Upgrade** > **FPGA Upgrade** on Configurator.



2. Search and select the provided FPGA upgrade file (*.bin) and click **Open**.

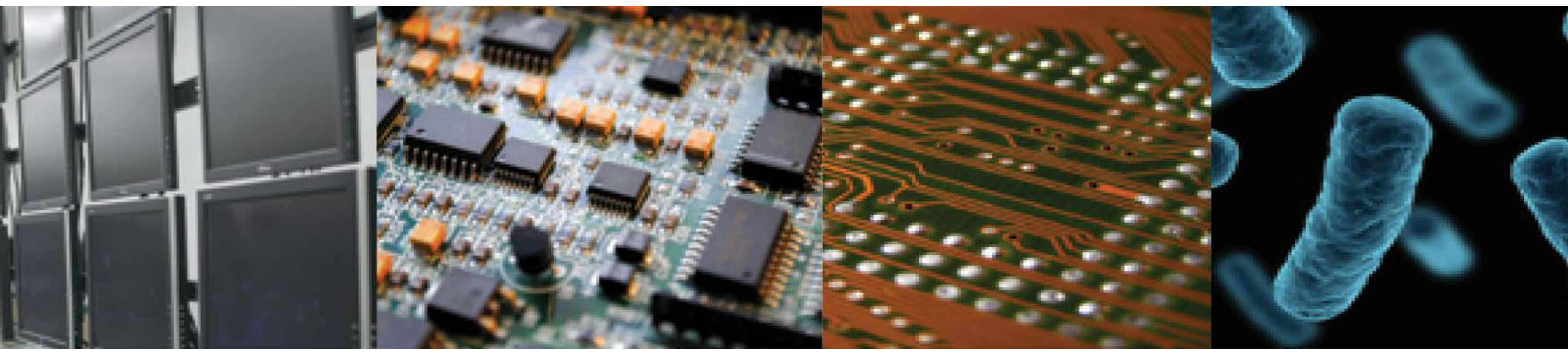


3. The subsequent processes are identical to those of MCU upgrade.

Appendix D Position settings according to sequence modes

Ratio for 1 Pixel

Order	4 Shot Mono		9 Shot Mono		4 Shot Bayer Color		16 Shot Bayer Color		36 Shot Bayer Color	
	X	Y	X	Y	X	Y	X	Y	X	Y
1	0	0	0	0	0	0	0	0	0	0
2	1/2	0	1/3	0	1	0	1	0	1	0
3	0	1/2	2/3	0	0	1	0	1	0	1
4	1/2	1/2	0	1/3	1	1	1	1	1	1
5	-	-	1/3	1/3	-	-	1/2	0	1/3	0
6	-	-	2/3	1/3	-	-	3/2	0	4/3	0
7	-	-	0	2/3	-	-	1/2	1	1/3	1
8	-	-	1/3	2/3	-	-	3/2	1	4/3	1
9	-	-	2/3	2/3	-	-	0	1/2	2/3	0
10	-	-	-	-	-	-	1	1/2	5/3	0
11	-	-	-	-	-	-	0	3/2	2/3	1
12	-	-	-	-	-	-	1	3/2	5/3	1
13	-	-	-	-	-	-	1/2	1/2	0	1/3
14	-	-	-	-	-	-	3/2	1/2	1	1/3
15	-	-	-	-	-	-	1/2	3/2	0	4/3
16	-	-	-	-	-	-	3/2	3/2	1	4/3
17	-	-	-	-	-	-	-	-	1/3	1/3
18	-	-	-	-	-	-	-	-	4/3	1/3
19	-	-	-	-	-	-	-	-	1/3	4/3
20	-	-	-	-	-	-	-	-	4/3	4/3
21	-	-	-	-	-	-	-	-	2/3	1/3
22	-	-	-	-	-	-	-	-	5/3	1/3
23	-	-	-	-	-	-	-	-	2/3	4/3
24	-	-	-	-	-	-	-	-	5/3	4/3
25	-	-	-	-	-	-	-	-	0	2/3
26	-	-	-	-	-	-	-	-	1	2/3
27	-	-	-	-	-	-	-	-	0	5/3
28	-	-	-	-	-	-	-	-	1	5/3
29	-	-	-	-	-	-	-	-	1/3	2/3
30	-	-	-	-	-	-	-	-	4/3	2/3
31	-	-	-	-	-	-	-	-	1/3	5/3
32	-	-	-	-	-	-	-	-	4/3	5/3
33	-	-	-	-	-	-	-	-	2/3	2/3
34	-	-	-	-	-	-	-	-	5/3	2/3
35	-	-	-	-	-	-	-	-	2/3	5/3
36	-	-	-	-	-	-	-	-	5/3	5/3



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